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Research on the Design of Pressure Vessel Fixtures for Nuclear Reactors

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Abstract: Nuclear energy, as a clean, pollution-free, almost zero emission of clean energy, is in line with the world's energy development direction. With the development and maturity of science and technology, the development of the nuclear industry has promoted all walks of life more and more obviously. Nuclear reactor pressure vessel is one of the key components, and its design and manufacture is directly related to the operation of nuclear power equipment. The production and manufacturing of nuclear reactor pressure vessel cannot be separated from convenient and reliable working fixture. This paper carries out the tooling design of the fixture, which effectively solves the support and positioning problems to be solved in the overall processing and lifting process, and makes contributions to the development of nuclear power industry.

Keywords: Nuclear reactor; pressure vessel; tooling fixture; tooling design.

1. Introduction

The development of nuclear power is a realistic choice to optimize the energy structure, ensure energy security and meet the energy demand of economic and social development. The development of nuclear energy industry cannot be separated from the promotion of related equipment manufacturing industry. As an important part of the nuclear power equipment, the process level and error control in the processing process of the nuclear reactor pressure vessel play a decisive role in the overall product quality. It has high requirements for the load and stability due to its high load and complex stress condition. And because of its application in the nuclear industry, it should have zero tolerance for its error rate and error rate, and its use is directly related to the national economy and people's livelihood[1-2].

In order to adapt to the development of The Times, respond to the national strategies and policies, and base on the quality control requirements of product processing, this paper designs the loading tooling with the function of adjusting the positioning, fixing the pressure vessel support and auxiliary lifting.

2. Equipment Profile

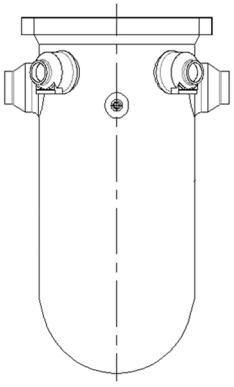


Figure 1. Outline diagram of the nuclear reactor pressure vessel

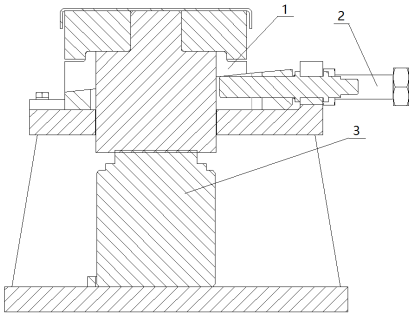
The nuclear reactor pressure vessel is a large casting piece weighing more than 300t. Figure 1 is the shape diagram. Its bottom surface is hemispherical surface, itself is cylindrical shape, the upper part of the uneven distribution of several receiver.

The processing process is mainly to process the upper flange plane, the inner cavity cylindrical surface and the takeover inner hole. Its processing requirements is necessary to make the upper plane and the workpiece axis and the machine related reference position error within the allowable range.

3. Design Ideas

According to the workpiece processing requirements, we mainly consider the tooling structure form from the following ideas:

First of all, it should be supportive to the workpiece. Using the support seat provided by the workpiece, the horizontal adjustment device is designed to play a supporting role in the support seat of the workpiece, and the device can be adjusted up and down, so as to adjust the levelness of the workpiece processing plane, so that the device mainly assumes the two roles of support and horizontal adjustment. Figure 2 shows a schematic diagram of the horizontal support device:

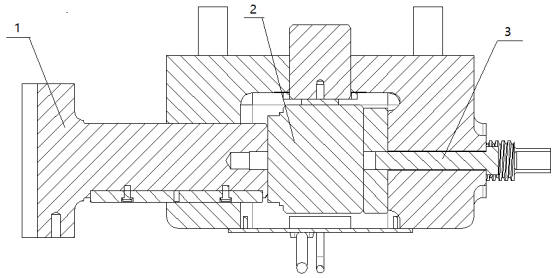


1.Wedge pad iron 2.lock screw 3. hydraulic jack

Figure 2. Schematic diagram of the horizontal adjustment device

The built-in hydraulic jack can adjust the height of the entire device to adjust the horizontal state of the workpiece. In addition, the top is equipped with wedge pad iron can be locked in the whole adjustment state after the adjustment, to prevent the workpiece from external force in the processing process.

The workpiece axis can be adjusted. With reference to the horizontal support device, a radial adjustment device can be set up to adjust the central axis of the workpiece through the hydraulic jack. Figure 3 shows the radial adjustment device:

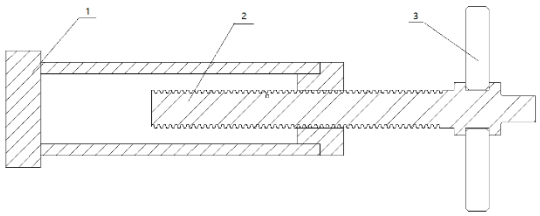


1. top claw 2. hydraulic jack 3. lock the screw

Figure 3. Schematic diagram of the radial adjustment device

The radial adjustment device has a built-in hydraulic jack, which covers the outer surface of the workpiece cylinder through the front top claw, and adjusts the central axis of the workpiece by adjusting the jack, so as to meet the precision requirements. After the adjustment, the adjustment state will be locked by locking the screw.

Multiple radial positioning of the workpiece in the vertical direction. Considering that the space size of the workpiece in the vertical direction is relatively large, in order to further ensure the stability of the adjustment state, a radial clamping device should be added at the lower end of the workpiece to use the positioning and clamp of the central axis of the workpiece, so that it can ensure the stability of the adjusted state. Figure 4 shows the radial clamping device:



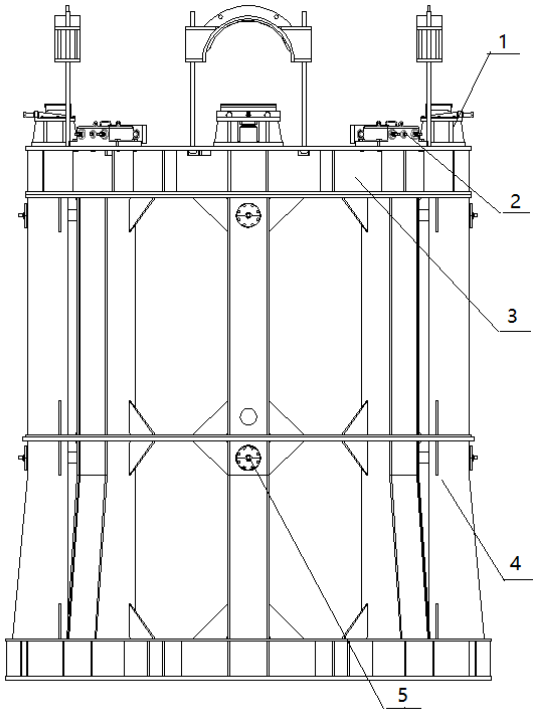
1.Top claw 2.T threaded screw 3.base

Figure 4. Schematic diagram of the radial clamp device

After the horizontal adjustment device and the radial adjustment device adjust the state of the finished piece, position the clamping device through the T-thread screw, adjust the top claw, and lock the top of the workpiece.

(4) Overall design scheme

According to the above design ideas, the main adjustment functions have been determined according to the needs of the work. According to the mutual installation relationship between the various structures, the various functional parts are connected through the design of the whole frame structure. The tooling is composed of foundation frame, positioning clamping device, platform, horizontal adjustment device, radial adjustment device, etc. Figure 5 shows the overall design scheme:



1.Horizontal adjustment device 2. radial adjustment 3.platform 4. foundation frame 5. radial clamping

Figure 5. Schematic diagram of the overall tooling scheme

The tooling instthe horizontal adjustment device and radial adjustment device on the platform device, and the radial clamp device on the frame structure, so as to ensure the overall stability and coordination of the tooling. Figure 6 shows the final assembly drawing.

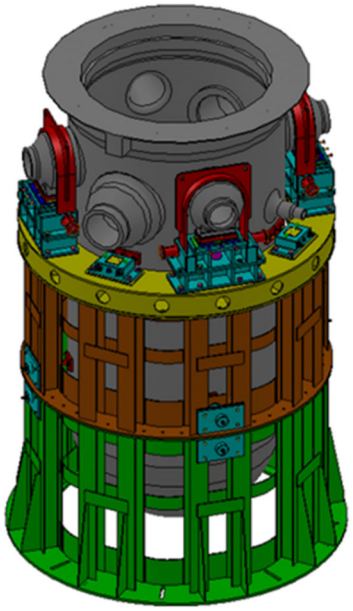


Figure 6. Final assembly drawing

Working characteristics of the tooling design: the tooling clamp mainly adjusts the accuracy and quality of the various benchmark elements of the whole UHV container workpiece part by hydraulic drive, and the hydraulic drive ensures the speed, stability, convenience and safety of the adjustment process. The plane positioning device and horizontal

positioning, the two groups of self-locking hydraulic jacks are adjusted successively to ensure that the whole adjustment process is efficient and convenient. After the adjustment, the wedge pad iron and bolt locking mechanism ensure the safety and stability of the adjustment state. In addition, using the structure of the ring set on the takeover form, can make the tooling with work lifting, and not using the tooling drive the workpiece lifting way, because the structure characteristics can minimize the tooling load in the process of lifting, can simplify the tooling structure form, very high overall equipment security, reduce the equipment cost.

4. Conclusion

According to the tooling requirements of nuclear reactor pressure vessel, this paper designs a fixture with adjustment and positioning, fixed support and auxiliary lifting functions to meet the processing requirements of ultra-high voltage vessel for nuclear power generation. The design of the fixture meets the processing requirements of the flange surface, the inner hole and the cylinder surface, and ensures the stability of the processing process and meets the requirements of machining accuracy. The fixture has the characteristics of reasonable structure, uniform force, convenient lifting, easy maintenance and maintenance. The design scheme of this paper has made bold innovation and improvement on the original basis, which has been recognized by the industry. It has accumulated some practical experience for the tooling design work in the future, and provides valuable material for the upgrading of products.

References

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