Analysis of Machining Process of the Hydraulic Cylinder Block with Interference Press Fitting

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Abstract: Because the inner hole of the cylinder is matched with the piston, and frequent relative motion is need, so the quality of its processing has great influence on the stability and reliability of the hydraulic cylinder. In this paper the overall process on processing technology of hydraulic cylinder block for pressing fit parts is designed, and its important implementation processes were analyzed, the clamping method and the fixture of inner hole machining are designed. These processes and measures are of significance to the processing of similar products.

Key words: pressing; hydraulic cylinder block; machining process analysis

INTRODUCTION

In the modern assembly workshop, a lot of pressing equipment is needed to be assembled. These large load pressing equipment is carried out by means of a special machine. At present, most of the special equipment is driven by hydraulic system and realize accurate positioning by the pressure sensor or stroke sensor in order to meet the requirements of assembly position and interference fit. Figure 1 is the part of the hydraulic cylinder block diagram with positioning press fit.

ANALYSIS OF PART DRAWING

The hydraulic cylinder is different from other inner hole machining parts, the inner wall of the cylinder is matched with the outer circle of the piston. The piston carries out frequent reciprocating linear motion in the cylinder, so that the processing quality of the inner hole of the cylinder affects the smooth operation, reliability and safety of the hydraulic cylinder. The size, accuracy and shape tolerance of the inner
hole are relatively high, and the surface roughness is very high at the same time. Because of its sealing requirements, it is hoped that the surface of the inner hole has a certain hardness and wear resistance to achieve the expected life expectancy.

The process analysis of the cylinder parts mainly includes the technical requirements, the shape and position tolerance, the roughness requirements and the selection of machining datum, the analysis of the mode of clamping, and finally the choice of blank. Can be seen from figure 1, the main part of the processing parts include holes, outer cylinder, inner thread hole and rounding and chamfer, etc. Some of the dimensions of the processing accuracy are higher, the tolerance value is relatively small. As shown in Figure 1, the roughness Ra of the inner hole surface of the part reaches 0.4, the diameter of inner hole is 100mm, the size tolerance is 0.03mm, the level of dimensional accuracy need level 7, and the tolerance of cylindrical of inner hole is 0.05mm, the perpendicularity that the two end faces of the cylinder are relative to the reference axis is 0.05mm, The coaxial tolerance between the supporting outer circle and the reference axis is 0.05mm. The diameter of the outer circle used to support is 122mm, The size of the accuracy of the grade is level 6.

![Figure 1. Cylinder of hydraulic cylinder.](image)

The machining difficulty of the workpiece is mainly the surface quality of the inner hole is higher and the dimension tolerance and shape tolerance requirement is high. The rigidity of the whole cutting system is reduced because of the large diameter ratio of the parts, so the vibration is easy to occur during the cutting process which can lead to the deterioration of the size of the taper and roundness error and surface roughness. Because of the requirements of the end face seal, the perpendicularity of the end face of the parts which relative to the reference axis of the parts is higher.

**DETERMINATION OF TOTAL PROCESS PLAN**

According to the hydraulic design handbook, the material of hydraulic cylinder usually select 20, 35, 45steel and other quality steel. In order to realize economic processing and save time, the cylinder blank material usually select the seamless steel pipe, cold drawn seamless steel pipe or hot-rolled steel pipe. According to the drawings and combined with the part dimension of parts, 45 steel with hot rolling seamless steel pipe is selected whose diameter is 133mm, and the wall thickness is 18mm and has a length of 309mm. Although the price of hot-rolled steel blank is relatively low, but there will be surface decarburization, and because of the size of the
error is larger, so larger machining allowance should be left to eliminate these defects. The processing technology of the hydraulic cylinder is analyzed by using the hot rolled steel tube as the blank.

The size of block processing mainly concentrated in \( \Phi 130h6 \), \( \Phi 122h6 \), \( \Phi 100H9 \). The processing precision reaches IT6 level and the processing precision is high. The processing requirements on tolerances are cylindricity, face runout degree, verticality and coaxiality requirements. Because the machining accuracy of inner hole surface is relatively high and the roughness of the outer surface of the part is Ra3.2 and the surface roughness of the inner bore is Ra0.4 so that the processing technology of the cylinder block of the hydraulic cylinder is [1-4]: blanking→Heat treatment (workpiece is vertically lifted into the furnace to reduce heat treatment distortion)→non circular grinding→the outer circle, the step and the end face of the end are turned roughly→the other end of the outer circle and the bench and the end face are turned roughly→Outer circle and step and end face of one end are turned finely→the other end of the outer circle and the bench and the end face are turned finely→Inner hole is bored finely and end face of one end is turned finely→rolling the inner hole→the total length is processed→punch→burrs are eliminated→clean.

ANALYSING THE DATUM OF THE PARTS

The datum of the parts is generally divided into rough and fine benchmarks. When the outer surface has not been processed which is used as a positioning reference, it is called a rough reference. The processed surface is treated as a benchmark, which is called the fine base. When the parts processing, in addition to the beginning of the process of selecting a rough benchmark, the other processing should choose fine benchmark.

Analysis by the parts diagram, when the parts was roughly machined, the axis hole should first be looking for is and is taken as the outer cylindrical outer circle processing benchmark to realize the size of diameter 130mm and a 122mm. The precise basis is the axis line with 100mm diameter holes.

THE IMPLEMENTATION OF THE MAIN PROCESSES

(1) Rough Machining of Cylindrical

Because of the larger diameter of the parts, it is necessary to select the CW6180/110 series of horizontal lathe. The three jaw chuck is used to clamp the parts and the axis of inner hole need to be alignment. The spindle speed of the machine tool is selected 85r/min, the allowance after rough machining is maintained at 0.6~1.0mm. Beat of distal inner hole need to be found after the parts is clamped to confirm the inner hole machining allowance. Because the work piece has been over - grinding, so the roundness of the outer circle of the blank is better. All this can ensure the position accuracy and machining allowance. The main angle cutter can choose 75°, in order to reduce the radial force during cutting and deformation.
(2) Rough Boring and Fine Boring Inner Hole

The outer circle is used to locate the inner hole when the coarse and fine boring, the end face is clamped, the parts is not affected in the radial direction. This can avoid the release of the deformation after the parts is processed. Boring bar must use heat treatment to improve the overall rigidity of the cutting system and high pressure cooling should be used in addition, especially in deep hole boring, this can reduce the error caused by taper axial thermal expansion to ensure the cylindricity of the inner hole.

(3) Rolling of Inner Hole

Because of the high surface strength and finish of the hydraulic cylinder, the rolling process should be taken into consideration. Rolling is a chipless machining, it is by the roller to extrusion parts of the surface that make the parts to produce plastic deformation which can reduce the roughness of the surface of the parts in extrusion[3], so the cleaning degree is high after rolling process and the cleaning is easy. In addition, the inner wall of the cylinder is formed by a layer of hardened hard layers after rolled, which forms a negative stress on the surface, this greatly improve the wear resistance and fatigue strength of the inner wall.

CLAMPING DESIGN OF INNER HOLE MACHINING

The choice of the way of clamping parts should be reasonable, and the following points should be taken into account when selecting the fixture:

1. From the cost of the economy, the choice of fixture should be the general fixture or standard fixture as far as possible.

2. Parts clamping (positioning and clamping parts) can not affect the processing and cutting tools to avoid the occurrence of collision phenomenon between the tool and fixture.

3. The rigidity of the clamping part is better to prevent the occurrence of deformation because of large clamping force.

Three jaw chuck has self-centering function better, but due to the diameter and length of the hydraulic cylinder are larger, and its weight is larger so as to produce center axis deviation of the hole easily if only three jaw chuck clamping is used. This caused the uneven wall thickness of cylinder, so combined with the structural characteristics of the parts, clamping can be designed for axial clamping in the boring hole as shown in Figure 2. This can avoid the deformation caused by the radial clamping, which can guarantee the size and shape of the inner hole effectively.
CONCLUSION

The machining quality of hydraulic cylinder has influence on the stable operation, reliability and safety of the hydraulic cylinder. Reasonable process scheme is the basis of ensuring the quality of machining. In order to ensure the surface roughness and dimensional accuracy of the inner hole, the rolling process is not only used but also the clamping is designed. These have a reference to the processing of similar products.

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