Application of welding robot in the manufacture of locomotive body

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Key words: welding robot; locomotive body; welding torch; manufacturing

Preface

The traction beams and bolster beams of the electric locomotive chassis are the key components of the locomotive. The quality of the welding of which directly affects the safety of the locomotive operation. In order to improve the stability of welding quality, improve production efficiency, make workers' working conditions better and reduce labor intensity, Zhuzhou Electric Locomotive Co., Ltd. introduced the Austrian IGM welding robot for the welding production of and traction beams and bolster beams.

Introduction of IGM Welding Robot System

The IGM welding robot system consists of a robot body, a control system, a positioner, a teach pendant, a remote control box, a tracking system, a welding system, and application software.[1]

The control system uses Pentium CPU and full digital signal communication to control the robot 6-axis, 3D gantry frame x, y, z-axis and positioner axis, and can extend 2 external axes. The robot body adopts a 6-axis toggle structure. A teach pendant and a remote control box as a human-machine interface are used for robot control. The tracking system uses three kinds of tracking methods: contact nozzle sensor, arc sensor and ELS laser sensor, which can track the welding seams of V-shaped, single V-shaped, fillet welds and plug welds.[2] The welding system uses the Fronius TPS5000 full digital controlled inverter welding power supply. In addition, the system is equipped with an efficient welding fume absorption and purification device and an automatic clearing torch, wire cutting, spray anti-splash oil device.

Application in locomotive body manufacturing

Single-axis positioner robot system applied to bolster beam welding. The bolster beam welding uses a single-axis head and tail frame type positioner. The bolster beam is welded into a box-shaped structure by upper and lower cover plates, vertical plates and partitions. After assembly, the four welds on both sides and the straight welds on the upper and lower surfaces are welded in a boat shape.

Double-axis positioner robot system applied to traction beam welding. The traction beam welding uses two double-axis frame type positioner systems. The traction beam is a complex multi-box structure. After the assembly is completed, the robot has a small operating space. Which causes the robot has a small degree of freedom. This requires a long time to program, and the programming skills are also higher.
Problems and solutions in the application of Welding robots

Analysis and treatment of welding defects. The robot uses argon-rich mixed gas protective welding. The welding defects that occur during the welding process generally include welding offset, undercut, and airhole.\[^{[3]}\] The specific analysis is as follows: (1) A welding offset may occur if the position of the weld is incorrect. At this time, consider whether TCP (the position of the torch center point) is accurate and adjust it. If this happens frequently, check the zero position of each axis of the robot and recalibrate it. (2) The cause of undercut defects may be improper selection of welding parameters, the angle or the position of the welding torch is incorrect. The power can be appropriately adjusted to change the welding parameters, and the posture of the welding torch as the relative position of the welding torch and the workpiece can be adjusted. (3) The reason for the occurrence of airhole may be poor protective gas and too thick primer for the workpiece. Or the shielding gas is not dry enough and can be treated with appropriate adjustments. (4) Excessive splashing may be caused by improper selection of welding parameters, gas composition or excessive elongation of the wire. The power can be appropriately adjusted to change the welding parameters, adjust the gas ratio meter to adjust the proportion of the mixed gas, or adjust relative position between the welding torch and the workpiece. (5) An crater is formed after the end of the weld is cooled, and the buried crater function should be added to the work step during programming to fill it.

Robot Fault Analysis and treatment. During the welding process, the robot system will encounter some faults\[^{[4]}\]. The common ones are as follows: (1) A welding torch collision has occurred. Which may be due to deviations in the assembly of the workpiece or inaccurate TCP of the welding torch. The assembly should be checked or the welding torch TCP be corrected. (2) An arc fault occurs and the arc cannot be induced. It may be because the welding wire is not in contact with the workpiece or the process parameters are too small, the wire can be manually fed, the distance between the welding torch and the weld be adjusted, or the process parameters can be adjusted appropriately. (3) Protective gas monitoring alarm. If there is a problem with the cooling water or the protective gas supply, check the cooling water or the protective gas line.

Welding robot application experience.

Workpiece quality. As a teaching-reproducing robot, it is required that the assembly quality and accuracy of the workpiece must be in good agreement. The application of welding robots should strictly control the preparation quality of the parts and improve the assembly accuracy of the weldments. Part surface quality, groove size and assembly accuracy will affect weld tracking. Parts preparation quality and weldment assembly accuracy can be improved in the following aspects. (1) Prepare the special welding process for the welding robot, and carry out strict technical regulations on the size of the parts, the weld bevel and the assembly dimensions. The tolerance of the general part and groove size is controlled at $\pm 0.8$ mm, and the error of the assembly size is controlled within $\pm 1.5$ mm. The probability of welding defects such as airholes and undercuts in the weld can be greatly reduced. (2) Use high precision assembly tooling to improve the assembly accuracy of the weldment. (3) Welds should be cleaned, no oil, rust, welding slag, slag and other debris, allowing for a weldable primer. Otherwise, it will affect the success rate of arc ignition. The spot welding is changed from electrode welding to gas shielded welding. At the same time, the spot welding part is polished to avoid residual slag shells or pores, so as to avoid arc instability or even splashing\[^{[5]}\].
**Welding wire requirements.** In order to reduce the frequency of replacing the welding wire, the robot should use the barrel welding wire, but due to the barrel welding hose is long, the resistance is large, and the quality of the wire is high. When the welding wire with poor copper plating quality is used, the copper plating on the surface of the welding wire will reduce the inner volume of the pipe due to the frictional drop, the resistance will increase when the wire is fed at a high speed, the wire cannot be smoothly sent out, the vibration is generated, the arc is unstable, and the welding will be affected seam quality. In severe cases, the phenomenon of jamming causes the robot to stop, so it is necessary to clean the wire guide in time.

**Programming Skills.** (1) Choose a reasonable welding sequence. The welding sequence is determined by reducing the welding deformation and the length of the torch travel path. (2) The space transition of the welding torch requires a short, smooth and safe moving path. (3) Optimize welding parameters. In order to obtain the best welding parameters, work specimens are produced for welding test and process evaluation. (4) Reasonably choose the position of the positioner, the posture of the welding torch, the relative position between the welding torch and the joint. After the workpiece is fixed on the positioner, if the weld is not the ideal position and angle, it is required to continuously adjust the positioner during programming, so that the welds are successively leveled in the welding sequence, and the position of each axis of the robot is continuously adjusted, reasonably determine the position, angle and extension length of the welding torch relative to the joint. After the position of the workpiece is determined, the position of the welding torch relative to the joint is difficult to observe through the eyes of the programmer. This requires the programmer to be good at accumulating experience. (5) Insert the clearing torch program in time. After programming a certain length of welding procedure, the cleaning torch program should be inserted in time to prevent the welding spatter from clogging the welding nozzle and the contact tip, ensuring the cleaning of the welding torch, improving the life of the nozzle, ensuring reliable arc ignition and reducing welding spatter. (6) The programming procedure is generally not in one step. It is necessary to continuously check and modify the program during the robot welding process, adjust the welding parameters and the posture of the welding torch to form a good program.

**Operating costs and management.** Imported robot parts are expensive, and efforts should be made to reduce operating costs in all aspects. Lubricants can find the same low-cost alternatives in our country for performance and utility. The maintenance of the welding robot should be strengthened during the welding process to improve the service life of consumable parts such as nozzles and contact tips. In addition, preventive maintenance of the robot system can effectively improve the service life of components. Highly qualified managers, technicians and operators are essential for the full efficiency of the robot. The quality of a company's welding robots is largely due to people, so it is necessary to ensure a stable staff.

**Conclusion**

The application of the welding robot in the manufacture of the traction beam and bolster beam of the electric locomotive body greatly improves the welding quality stability and production efficiency. The application of welding robot is a complicated and comprehensive process, which puts new and strict requirements on the design structure of the weldment, the welding process, the quality of the parts and the assembly quality of the weldment. At the same time, the stability of the relevant staff also affects the quality of the robot application. It should be accumulated in the long-term application to maximize the benefits of the robot.
References


