

REPAIRS OF THE HYDRAULIC CYLINDER OF 3500T GRAPHITE EXTRUDER STRAIN

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Abstract

Pulse cold welding, brushing electroplating, precision argon-arc welding, adhesive composite technology, are important technical methods to repair the surface of metal parts, they can produce a variety of special features on the surface of the composite layer. A very small amount of repair material will be able to get a high effect more than a lot of expensive materials' and reduce the production costs, also supply an economic and efficient solution to repair the mechanical equipment with large economic losses caused by the scrapped parts which surface was damaged.

1 Introduction

June 16, 2007, the key equipment of 3500t graphite cathode extruder cylinder of a company in the northwest was damaged seriously, which had a direct impact on the production. They contacted the manufacturer - a heavy machinery factory in Shanghai, to purchase or repair the hydraulic cylinders. The factory could only supply a new hydraulic cylinder models, priced at about 3,000,000 yuan, a year and a half of delivery. But a long delivery would cause large economic losses. In this case, the special repair had to be the best choice.

Carbon extruder is best and key equipment in carbon trade, and the extrusion cylinder is the most important part for the extruder. Injury in the body makes hydraulic oil leakage, the pressure fell too fast, finally leading bad quality products to be produced.

Pulse cold welding, brushing electroplating, precision argon-arc welding, adhesive composite technology, are important technical methods to repair the surface of metal parts, they can produce a variety of special features on the surface of the composite layer. A very small amount of repair material will be able to get a high effect more than a lot of expensive materials' and reduce the production costs, also supply an economic and efficient solution to repair the mechanical equipment with large economic losses caused by the scrapped parts which surface was damaged.

2 The technical conditions and injuries

The equipment was put into use in 2003, due to the long-term continuous operation, equipment hydraulic

cylinders was injured seriously and pressure is not enough, thus caused the decline in the rate of qualified products. Hydraulic pressure related to some of the technical parameters, technical requirements, quality inspection and injuries are as follows:

2.1 Technical requirements

The repair of the above hydraulic cylinder should meet the technical requirements of the following:

The piston with cylinder work, Pressure, leakage, surface hardness, and other requirements. To keep the temperature range of -5 to +60 degrees Celsius for hydraulic cylinder working.

2.2 Technical parameters

General length of hydraulic cylinder was 4240mm, wall diameter was 1120 mm, length of piston is 4825 mm, the piston head was 400 mm, piston weight was 17600kg, body weight was 18000kg. Materials was 20MnMo, after forging the hardness was HB207-269. By ultrasonic testing the injury reached JB4730 □ level of -94. And the surface roughness was Ra = 0.8.

2.3 Injuries

The whole body injury, including two large depth of the strain which were 400 mm × 2500 mm and 200 × 2500 mm, and the deepest was about 8 mm. Piston rod seal groove had two large strains which were 30 mm × 40 mm and 20 mm × 30mm and the deepest was about 30 mm.

2.4 Quality inspection

Hydraulic cylinder renovated was in charge of third-party inspection. Pressure to be 22MPa without leakage and the equipment on normal operation were as inspection standards.

3 Confirm the repair methods

There is no a precedent of scene repair of large-diameter cylinder at home and abroad. **HEFEI METAL SURFACE ENGINEERING CO., LTD.**, with technical support from the New Technology Office of the People's Liberation Army Armored Force College of Engineering, took this repair. In view of the injuries in

the hydraulic cylinder, a single repair method was not feasible. The better repair should be: hydraulic cylinder dismantles firstly, use pulse cold welding or electric spark deposition, then polished on machine tool. However, the demolition time would be very long and costs would be very high. Another method was scene non-disintegration repair, but also had the defects. The most drawback was the accuracy of size would be lower. In order to get the desired effect of repair, we did a simulation test in our own workshop. Through testing several different repair processes, the results were analyzed as follows:

3.1 Two large injuries

These two injuries could be repaired by the pulse cold welding or electric spark deposition. As the pulse cold welding and electrical spark deposition are all spot welding, work efficiency is low, about 3 months would be needed. This is difficult to ensure the accuracy of inner size and surface finish, especially operation capacity of scrape would be very high. Besides, brushing electroplating is no use for the deep injury. Precision argon-arc welding or electric welding can cause the stress inner and distortion of body, also ensure the accuracy difficultly. Arc spraying can solve these problems, but the space in tank can not meet the requirements of the scene repair, the combination strength is not applicable, so arc spraying had to be abandoned. After analysis we found adhesive composite technology was the most feasible and efficient method of repair. To achieve the desired effect and accumulate experience, we used our own types of adhesives on different parts, one was wear-resistant adhesive, the other was friction-adhesive.

3.2 Other minor injuries

There were some minor injuries in the body which were thin stripes in vertical direction covering the whole body. Some minor injuries could be repaired with pulse cold welding and brushing electroplating combined. Some narrow and deep stripe could be repaired with pulse cold welding to recover the size rapidly. And for some small and shallow injuries, we had to expand the injuries to expose the underlying, then brush plated largely.

3.3 Piston rod strain

Piston rod was injured seriously and couldn't be repair by pulse cold welding except high-precision welding machine. The valley current of 5 amps had small thermal effect on the body. Local body could be recovered the size with brush plating.

3.4 Copper sheathing strain

Some deep thin stripes in copper sheathing, if repair with brush plating time would be very long and material cost

very much. While the electric spark deposition was an effective method to resolve the welding problems to non-ferrous metal.

According to the above analysis, we made a specific repair program: to repair the two large injuries with adhesive, To repair some minor injuries with pulse cold welding combined with brush plating. To repair the piston rod with argon-arc welding combined with brush plating. To repair copper sheathing with electric spark deposition combined with brush plating.

4 The construction process and related issues

4.1 Construction of adhesive technology and technical requirements

4.1.1 Pre-construction: Construction first start from two tanks of the most seriously injured parts. As the area of injury is too large, gum curettage can not be accomplished in an action. The whole areas of the seriously injured parts are divided into 6 small relatively ideal areas, which will be finished separately. Before scraping, gum base should be decent for oil cleaning, which should be done thoroughly, otherwise it will lead to the failure of the entire restoration. The oil cleaning first start from part, cleaning oil entirely may cause corrosion of the un-timely repaired parts. The oil cleaning process protects the non-restoration surface, firstly use a relatively low price of liquid detergent for the surface's rough oil cleaning, but the porous matrix may have infiltrated oil pollution, secondly take oxyacetylene flame baking to clean oil, the baking should be done repetitiously, until the surface has no permeability after 12 hours, finally use medical cotton to scrub carefully. After oil cleaning is the surface finishing, by using angle grinder, grinding head pen, emery cloth, and so on. Angle grinder on the strain of the irregular surface processed to remove sharp edges, the burr. And then use the blade, diamond mold after twisting, and remove the fatigue layer and the oxide layer of the surface. It should be noted that the grooves do not need to draw, uneven matrix can increase the adhesive bonding of the matrix. But prominent edges should be grinded to about 1 mm below that part of the base level, to ensure that the adhesive bond strength of the matrix. Protection of the non-adhesive parts should be done before adhesive, by using transparent tape or plastic sheeting.

4.1.2 Coating: To maintain base-level dry and clean, first use silane coupling agent to coat the substrate surface thin and equality, coupling agent has been diluted with high-purity medical alcohol in proportion. Glue mixing can be done during the drying time of coupling agent, mix in proportion by the prepared two groups, mix the two groups on plastic in the same direction, so that the two groups mixed evenly. Glue

gelatinize after the coupling agent is thoroughly dried, the glue gelatinize is divided into two steps: The first step is to scratch base glue, which is to coat a thin layer glue by hand which is protected by rubber gloves on the coupling agent coated dry surface, no dead stay, the layer is the thinner the better. The second step is the glue scraping, scraping gum has to scratch in the same direction, to avoid bubbles. The thickness is close to the original size. After the glue scraping we should pay attention to the impact of temperature on the adhesive, and can not have a running phenomenon.

4.1.3 Fine grinding: Such as the plastic solidified after coarse grinding, the first part of the uneven worn glue, and then use tools like-fine grinding with emery cloth, abrasive profiling is a good tool steel processing, the degree of arc than the diameter of a round cylinder block Slightly smaller arc, aside from the size of emery cloth.

4.2 Construction process of cold welding and brush plating technology and technical requirements

4.2.1 Construction pre-treatment: First of all, the less injured areas are divided into 16 relatively satisfactory repair regions, and be repaired separately. Before repairing, gum base should be decent for oil cleaning, which should be done thoroughly, otherwise it will lead to the failure of the entire repair. The oil cleaning first start from part, cleaning oil entirely may cause corrosion of the un-timely repaired parts. The oil cleaning process protects the non-restoration surface, firstly use a relatively low price of liquid detergent for the surface's rough oil cleaning, but the porous matrix may have infiltrated oil pollution, secondly take oxyacetylene flame baking to clean oil, the baking should be done repetitiously, until the surface has no permeability after 12 hours, finally use medical cotton to scrub carefully. After oil cleaning is the surface finishing, by using angle grinder, grinding head pen, emery cloth, and so on. Angle grinder on the strain of the irregular surface processed to remove sharp edges, the burr. And then use the blade, diamond mold after twisting, and remove the fatigue layer and the oxide layer of the surface. We should open a trench, small stripes to open groove, so as to ensure the normal work of the brush. Protection of other parts should be done before repairing, by using transparent tape or plastic sheeting.

4.2.2 Cold welding and brush plating process: First of all, weld the deeper cut of the entire block, welding material selects stainless steel. As the cylinder is vertical, construction is difficult. Cold solder joints must be fine and do not appear bright spot welding and leakage, otherwise will find a leak. Welding of catch-brand shows that the oil is not a net or a sharp edge, and so on, must be properly addressed. Grinding after Welding must be careful, and must be done strictly

in accordance with the basic requirements, and also should protect the base level. The size after grinding must be about 2 micron less than the base level. After the welding process, it comes the part brush, before scrub brush use of acetone to clean the surface, and protect the non-plating areas. Make a slot under the plating area to facilitate the recovery of the bath, and also to prevent the bath and water pollute the lower side of the non-coating part. As the space of the cylinder is small, in order to keep the air flow during the brushing, we have put in the mouth of a fan for ventilation. In between each process, use warm water to carry out thorough cleansing, do not use cold water. Each conversion between processed must be smooth, pending coating layer must always be in a wet state. Electric cleaning is a net oil electrochemical steps which the time should not be too short, and should according to the provisions of Technology normative operation. When activating, should pay attention to the electrode reverse, wash thoroughly, after the activation appears the fresh, clean metal matrix. If it can not reach the required effect do not just plating, it is necessary to re-clean the oil and re-activation. No electricity is a necessary step, there is an even special nickel plating bath on the surface in order to guarantee the quality of play. 18-volt high-voltage from the plating process called flash plating, which can increase the deposition rate of metal ions, to get the dense layer of coating. When restore the size use copper for base layer size, fill the small trench, when filling the trench may be repeated plural times to return to the standard size. Technicians are required to be patient and careful, and can not in order to save troubles and eager to accomplish in an action. During brushing process we should pay attention to the color coating at any time and should stop when found that coating appear dark color, points, rough, peeling and so on. After grinding to the grass-roots level and then re-plating. If the coating layer is too thick, we can use the sandwich to fill the trench, the sandwich layer coating can improve the internal stress, select the rapid nickel for the sandwich layer, and if coating layer is thicker, layer of the sandwich can be used for many times, layer of the sandwich can not be too thick. The surface selects the rapid nickel as working layer.

4.2.3 Fine grinding: Using the at the beginning of work prepared profiling tools and hand-polished way to restore the original dimensions, use part polished way to remove the high point, high polished as a whole is used in profiling the external surface of the abrasive pad of emery cloth Method for grinding again, to make up for low-plated. Head of emery cloth is from small to large, up to meet the requirements of precision and smoothness.

4.3 Precision argon-arc welding and cold welding repair process

4.3.1 Pre-construction: Before repairing, gum base should be decent for oil cleaning, which should be done thoroughly, otherwise it will lead to the failure of the entire repair. The oil cleaning first start from part,

cleaning oil entirely may cause corrosion of the un-timely repaired parts. The oil cleaning process protects the non-restoration surface, firstly use a relatively low price of liquid detergent for the surface's rough oil cleaning, but the porous matrix may have infiltrated oil pollution, secondly take oxyacetylene flame baking to clean oil, the baking should be done repetitiously, until the surface has no permeability after 12 hours, finally use medical cotton to scrub carefully. After oil cleaning is the surface finishing, by using angle grinder, grinding head pen, emery cloth, and so on. Angle grinder on the strain of the irregular surface processed to remove sharp edges, the burr. And then use the blade, diamond mold after twisting, and remove the fatigue layer and the oxide layer of the surface.

4.3.2 Precision TIG cold welding process:

when welding we must control the argon gas flow reasonably, as far as possible we should use the small welding current, to avoid overheating causing heat generated effects and produce stress. Welding can not be processed continuously, the appropriate suspension is also one of the measures to avoid high-temperature. For welding defects we use pens and angle grinder for coarse grinding head-dressing, after finishing, the porosity defects, such as trachoma, we can use the part cold welding to repair until they reach their technical requirements.

4.3.3 Fine grinding: Use the on-site processed profiling tools to restore the original size, For the obviously high point, we use part polished way to remove high polished, high polished as a whole is used in profiling the external surface of the abrasive pad of emery cloth Method for grinding again, to make up for low-plated. Head of emery cloth is from small to large, up to meet the requirements of precision and smoothness.

5 Acceptance and effect of operation

In nearly a month, professionals use many ways as the cold, brush plating, welding, adhesives and other methods to repair the pre-extruder pressure cylinder, At beginning of August, company commissioned the technicians from third-party companies to check size and finish of the repaired surface. After the third-party technicians' repeatedly measurement, the diameter of cylinder block is $11200+0..26$, the outer diameter of pistons is $1119.4-0.260$, all data of the restoration meet the technical requirements, the pre-pressure tank installation is completed at the end of August. After air load test, it reaches the test load conditions.

For the upcoming load test, we need to determine the restored 3500t extruder parameters of the production process to ensure that the extruder can maintain long-term stability of the operation, and also to guarantee the physical and chemical indicators of product quality and internal stability. Company and repair technicians agreed that the pressure could be

lower the pre-stress, but should match the lowest indicators of physical and chemical products. At the same time, refer to the extruder parameters of other factories, extruder with load testing program carried out a full technical discussion and analysis, the discreet project makes a complete success of the load test.

So far, there is no drop in pressure since the device is put into operation, during this period, we opened shelters for 6 times to inspect and found no new injury, only small part of glue surface peel off, after refilling glue, it did not appear abnormal.

6 Conclusion

Concluding from the repair process and results that scene non-disintegration of repair for large-scale hydraulic cylinders is feasible and successful. For large-scale to be decomposed difficultly, or after disintegration transport or processing is not convenient, scene repair process is the optimal choice. Firstly, scene non-disintegration of repair process avoids a long time re-machine; Secondly, the repair cost is saved very much. Time and cost are key issues for the company's profit, qualified products and timely delivery are necessary for enterprise's survival and development. The total repair time was 45 days from injuries occurred to completing repair, including the overhaul and maintenance for the other parts of the equipment. Timely repair assured product quality and delivery so that the enterprise could keep the continuous production. If purchased a new cylinder, including installation and transportation cost would be about RMB5,000,000, two years needed from purchasing to installment and operation, the enterprise would not only lost all the orders, but also to bear substantial Compensation, not to mention the profits of two years.

Against the background of increasing emphasis on recycling economy, repair and remanufacturing have taken to the stage of history. More and more techniques were invented and applied. The practice provide some examples for the invention. As always focusing on the invention and promotion of the repair technology is the mission of re-manufacturing enterprises, also is to meet needs of the industrial enterprises and community. More and more actual application of this technology are at expectation.