

The Research and Application of Zinc Dross Removing Robot in Galvanized Production Line

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Abstract: A large number of zinc dross will be produced on the surface of zinc bath, which then will be gathered and have a serious impact on strip surface quality, thus removing zinc dross and placing it in a dross container timely is a must in galvanizing production line. At present, zinc dross removal is executed performed by humans, which has many problems such as potential safety hazards, poor working conditions, difficulties in controlling dross-removal process and enterprise costs. Robotic solutions were employed to replace humans in zinc dross removal in foreign steel enterprises, which has obvious advantages in terms of safety, cost reduction and efficiency. The research of dross removal robot in domestic has just started, China iron and steel research institute and Ma-steel jointly developed a dross removal robot, with intelligent and efficient, reasonable configuration characters, which has been used successfully in Masteel.

1 BACKGROUND

By 2013, China is the world's largest consumer country for industrial robots which are widely applied in automotive, electronics, metal processing, food, beverage, rubber and chemical industries (Wenli Liang, 2015). While in steel industry, the research and application progress is relatively slow, due to its characteristics such as process modularization, large equipment scale and highly automated.

It is a general trend to employ robots to replace labour for production, with the increase of labour cost in recent years. At present, the robots is mainly used in the auxiliary process of iron and steel industry such as transportation, welding and disassembly.

In the field of deep processing steel, continuous hot-dip plating process equipment is one of the focus. At the meantime, the bath pot is the core equipment of production line. Many zinc dross will be produced on the surface of zinc bath, which then will be gathered and have a serious impact on strip surface quality, thus removing zinc dross and placing it in a dross container timely is a must in galvanizing production line (Song Xinli, 2009; Jiang Guangrui, 2015; Zhang Yanwen, 2013).

Currently, zinc dross removal is done by 1-2 people, who need to wear protective clothing, splash helmet, anti-noise earpad, and safety belt to ensure the safety as shown in figure 1. The following problems exist during this process.

1) security risks. In the operation process, the workers are only 0.2 meters away from the high temperature liquid zinc. Added in the complex dross removal operation, there is a higher personal safety risk.

2) Abominable working environment. The temperature of liquid zinc in the bath is about 460 centigrade and the ambient temperature of the working position is about 80 centigrade. The noise of the gas knife up to 120 DB combines with a large amount of dust. The amount of dross for the single operation is about 30 kg and 3 tons a day. Thus the dross removal is a high intensity work and are executed in a hot, noisy and polluted environment, which seriously affects the staff health.

3) Difficulty to control dross removal process which affects the strip quality. The process dross removal depends on the worker's experience, thus the frequency and the standard are out of control, especially for automotive and high-grade household strips.

4) Difficulty to control enterprise cost. The amount of zinc contained in dross is about 30%, cost increased 24.5 yuan per ton.



Figure 1: manual operation

2 RESEARCH AND APPLICATION OF DROSS REMOVAL ROBOT IN FOREIGN COUNTRIES

Q-ROBOT ZINC of Danieli Group (MerluzziA, 2017) is widely used. The working principle of Q-ROBOT Zinc is based on an industrial 6-axis anthropomorphic robot with its own control system that skims the surface of the zinc bath to remove dross, and places it in a dross container, using a specially designed tool as shown in figure 2. At last, when the container is full, the operator will change another container.



Figure 2: Danieli Group Q-ROBOT ZINC

Q-ROBOT Zinc has been used successfully, especially in zinc savings due to the optimized zinc dross skimming operation in Marcegaglia and Arvedi.

Overall, the Q-ROBOT ZINC has the advantages of simple structure, convenient maintenance and high reliability. However, the Q-ROBOT ZINC slag-cutting robot is still in the first generation of industrial robots, and which is of high price.

3 RESEARCH AND APPLICATION OF DROSS REMOVAL ROBOT IN CHINA

The research of dross removal robot started relatively late in China (Dai Xichun, 2017). Many large state-owned enterprises such as China Iron and Steel Research Institute(CISRI), Bao-steel, Shougang and MaSteel carried out the research and application of dross removal robot and achieved certain achievements. However, the mature solution has not been formed yet. In February 2016, an on-line dross removal robot system which was designed according to operating habits and processes and can meet the production requirements of the Masteel galvanizing line, was developed by a joint R&D team in CISRI and MaSteel.

Demonstration project (Figure 3) of galvanized line dross removal robot developed by CISRI and Masteel jointly, realizes the whole requirement of users correctly in May 2017. The dross removal robot belongs to the third-generation industrial robot, which took the bath pot and its peripheral equipment into consideration, with the characters of high intelligence, reasonable configuration et al. It was designed according to operating habits and processes. The process has reached the advanced level of similar products in developed countries, which contains 22 kinds of processes (Figure 4) for different components zinc bath and different kinds of strips.



Figure 3: On-line dross removal robot system developed by CISRI and MaStell

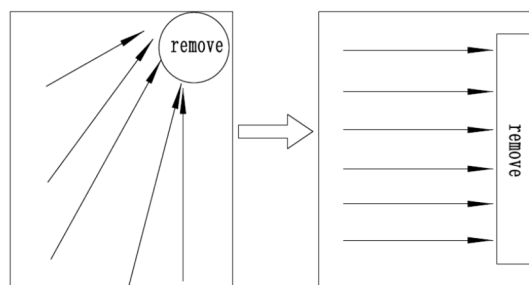


Figure 4: Manual process evolution to robotic process

Many experiments, such as hardware and software reliability tests, crash reliability tests, dross removal efficiency tests have been conducted and great improvements has been made during the debugging process. Experiments results show that the equipment is reliable, efficient and reasonable, which can meet production pace of 2 # galvanizing line in Masteel. The distribution of zinc dross on the zinc bath surface (before and after operation) are shown in figure 5.

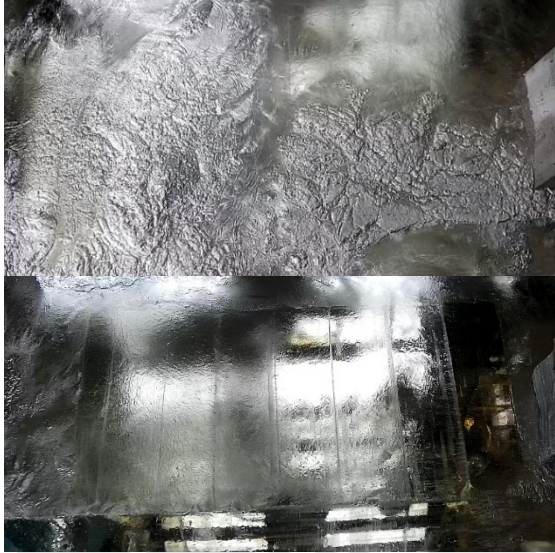


Figure 5: Zinc bath surface picture (before and after operation)

The robot has a protection class IP67, and wear protective clothing, with the ability of splash, dust, heat resistance, which means it is well protected against dust leakage and high temperature. The robot's HMI is programed using C# language and is human friendly.

The dross removal robot can control position of the special tool precisely, thus the depth of removal tool in zinc bath is keep constant less than 10 mm, making the liquid level fluctuations in the bath minimal and production stability improved greatly. The level of technology reached the first-class level of similar products in developed countries

Compared with the existing international equipment, this device has following advantages.

(1) Dross removal tool has little effect on the composition in zinc bath, which was treated specially, thus has no infiltration of zinc liquid, can increase service life.

(2) Integrated many different sensors such as vision, level, collision et al. thus it can remove the zinc dross intelligently.

(3) Little changes in operating habits, makes it easy to be accepted by operators.

(4) Adopting small arm development robot, has low environmental requirements.

To sum up, the system can save investment and operation cost, which has high dross removal efficiency and less loss of zinc.

At present, the equipment has been used successfully in 2# Masteel galvanizing line. Due to the use of the robot, a worker can be replaced at least in each shift group. Thus 200,000 yuan can be saved in a year (50000 yuan per year a person) .

4 CONCLUSIONS

The research shows that the robot can effectively skim the zinc dross from the surface of zinc bath in the galvanizing line and can reduce the production cost and replace the manual operation in the harsh environment, with the advantages of simple structure, convenient maintenance, good reliability and high cost performance. It has been promoted gradually in China.

REFERENCES

- Wenli Liang, Global robot market statistics data analysis[J]. Robot Technique and Application, 2015,(1):44-48.
- Song Xinli, Yuan Zexi, Wang Di. Effect of Hot Galvanizing Process on Surface Defect of Galvanized Steel Plate for Automobile[J]. Special Steel, 2009,30(3): 48-49.
- Jiang Guangrui, Liu Libing, Wang Zicheng, et.al. Analysis Techniques About Dot Defects on Coating Surface of Hot-Dip Galvanized Sheet[J]. Steel Rolling, 2015, 32(5): 40-44.
- Zhang Yanwen, Chen Yu, Xu Zhutao, et al. Methods for analyzing linear defects of hot galvanizing sheet: a discussion[J]. Journal of Wuhan University of Science and Technology, 2013, 36(3): 186-189.
- MerluzziA, Brunetti G. Metals industry: Road to digitalization[C].Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2017 40th International Convention on. IEEE, 2017: 967-973.
- Dai Xichun, Wei zhongshuang, Application research on dross removing equipment in hot dip galvanizing pot[J]. Metallurgical Industry Automation, 2017, 41(2): 10-14.