Research and Design of Automatic Chip Removal Model Based on Cutting Machine

Yaping Lu1*

1 Applied Technology College of Soochow University, Suzhou, Jiangsu, 215325, China

*Corresponding author’s e-mail: luyaping@suda.edu.com

Abstract. Aiming at the widespread environmental pollution problem of cutting machine tools, an automatic chip removal model platform is designed based on solid works. The model platform has the functions of automatic collection of waste chips and automatic chip removal through the air guide groove. A new type of cutting seam is designed to prevent the scraps from being taken out by the cutter, and remove the scraps adhered on the cutter due to high temperature. The inner loop gas path is designed, which is composed of two air inlets and 180 degree evenly distributed air outlets, forming a unique annular gas path. The gas path relies on the annular gas path, which blows away the waste chips during the cutting work of the machine tool, and enters the inner cavity of the machine tool through the new cutting seam. The automatic chip removal model platform is based on the chip removal of the machine tool itself, which can improve the chip removal efficiency of the waste and reduce the scratches on the surface of the material.

1. Introduction
Cutting is the processing method needed by the main processing enterprises, and the scraps produced by cutting are perplexing the environmental problems and product quality of enterprises. Although each cutting machine tool has its own chip removal system, waste chips are often splashed on both sides of the cutting gear during the cutting process. The waste chips remain on the chip working platform, affecting the entire working environment and even scratching the surface of the profile. Therefore, a working platform that can automatically remove chips is designed, and the chip removal efficiency is further improved on the basis of the cutting machine's own chip removal.

The following are the general cutting machine equipment for example, cutting objects for doors and windows, glass curtain wall used in various aluminum profiles. Cutting bed equipment has its own chip system, in the high-speed rotation of the cutting teeth, to drive aluminum chips into the machine interior, and through the industrial vacuum cleaner to remove aluminum chips. The vacuum cleaner draws out the falling aluminum chips through the exhaust hole, but it does not guarantee that 100% of the aluminum chips can be taken away. Even if the vacuum cleaner is in good condition, only 80% of the aluminum chips can be removed. Moreover, after the vacuum cleaner has been used for many years, the effect is obviously reduced, so that some aluminum chips are splashed on the worktable from both sides during the cutting process, or pasted on the saw blade, and then thrown back to the working table again. As shown in figure 1. After repeated cutting, the aluminum chips remain on the work surface, and the staff use pneumatic guns to remove aluminum chips to avoid a series of problems such as surface scratching or sticking to the surface of the profile. But the blown aluminum
scraps once again destroy the whole working environment, causing serious secondary pollution on the working ground and attached objects\cite{1-2}. As shown in figure 2.

Fig.1 Residual aluminum chips on the worktable

Fig.2 Working environment (site) pollution

2. Worktable design

According to the current situation of cutting machine equipment in the society, without changing the equipment, a cutting table model with automatic chip removal is designed, which can be easily and quickly installed on the original cutting machine equipment. Three aspects are considered in the design of worktable model: automatic collection of aluminum chips, automatic removal of aluminum chips and pneumatic circuit design.

2.1. automatic collection of aluminum chip

Designed with a triangle (acute angle) work table, with better chip removal effect. As shown in Figure 3, the symmetrical cross section of the triangle is shown. The aluminum chip produced during the cutting will fall into the triangular groove. The triangular grooves are symmetrically discharged on both sides, and the middle cutting seam is the symmetry center. The inclination of the triangular groove is mainly to facilitate the promotion of profiles. If it is in parallel with the movement direction of the profile, it may cause the profile to fall into the triangular groove. At the same time, the top end
of the triangle is designed to circular arc, so that the worker can not only scrape the surface while pushing the profile, but also play the role of lubrication in the design of the arc. It can be easily pushed to cut the profile.

![Fig.3 Triangular table cross section](image)

2.2. automatic aluminum chip removal

The automatic chip removal design includes the design of chip removal about the cutting seam, the design of chip removal about the cutting blade. The combination of them effectively improves the chip removal efficiency.

2.2.1. the design of chip removal about the cutting seam: Aluminum scraps fall in the triangular groove, through the pneumatic blown into the cutting seam, the cutting seam design than the previous gap is narrow, narrow cutting seam design can make the cutting process is not easy to splash out the aluminum chips, But the aluminum chip that has been splashed in the triangle groove is harder to blow to the cutting seam, Thus creating a unique gap at the edge of the cutting seam of each triangular groove, increasing the chance of falling aluminum chips. At the same time rely on the high-speed rotation of the cutting teeth, driven aluminum falling down. The detailed design of the cutting seam is shown in Figure 4 on the front and back. In order to increase the probability of aluminum chips falling in the chip seam, a cutting gap is designed at the chip seam.

![Fig.4 Detailed design of cutting seam](image)

2.2.2. the design of chip removal about the cutting blade: In the cutting process, there are always some aluminum chips in high temperature cutting stick on the cutting plate, and in the second cutting, fall on the work platform or profile. To eliminate the above problems, a pneumatic nozzle is designed at the cutting seam toward the center. The nozzle is facing the cutting blade, and remove the aluminum chip stick to the cutting blade. As shown in figure 5. The nozzle is designed at the lower part of the work
table, and the injection direction corresponds to the lower half of the cutting blade to prevent the aluminum chips are ejected from the chip seam so that the aluminum chips stuck on the teeth are ejected into the inner cavity of cutting bed. At the same time, it relies on the industrial vacuum cleaner in the inner cavity of the cutting machine to suck away the aluminum scraps, so as to eliminate the scraps from the outside to the inside.

2.3. pneumatic circuit design
The pneumatic circuit platform is designed, and the annular gas path is slotted inside, rely on two gas holes to enter the air. As shown in figure6. A uniformly distributed air hole is arranged on the inner wall of the ring, and the pore distribution is less than 180 degrees. The advantages of the design can meet the needs of the worktable to rotate any angle. Machine cutting angle is determined according to the requirements of cutting profiles, and some profiles require tangent is vertical, and some profiles require tangent is tilted, so often need to turn the worktable. As shown in figure 7. The worktable rotates at any angle and has holes corresponding to the triangular grooves to ensure that each triangular groove has more than 1 exhaust holes corresponding to each other[4].
3. Equipment cutting worktable

The worktable is composed of three parts, including the triangular groove platform, scrap platform and the pneumatic circuit platform. The triangular groove platform is designed to be symmetrical on both sides into 45 degree fan-shaped shape. The triangular groove is installed on the scrap platform. Finally, the aluminum chip is blown off by the blowhole on the pneumatic circuit platform. As shown in figure 8. After the design of the worktable, it can be installed directly on the worktable of the cutting bed. As shown in figure 9. Imitate the size of general cutting machine, use solid works software to do part drawing design and assembly drawing design. After installation, it does not affect the main structure of cutting bed, only increase the height of the original worktable[5].

Fig.7 the triangular grooves and exhaust holes

Fig.8 worktable assembly drawing
4. summary
The design adopts the triangular platform with rounded corners, which can play the role of automatic chip collection, apex Angle guide round can reduce friction, reduce aluminum surface scratches. Aluminum chips of triangular groove rely on air pressure to blow the chip to the cutting seam. Designed a unique gap in the cutting seam, and the aluminum chip is discharged by the high-speed rotation of the cutting blade. At the same time, the aluminum chip sticking on the the cutting blade is excluded by the Port which is facing the cutting blade, so that the aluminum chip is prevented from flying out at high speed. About pneumatic internal circuit design, there is a unique annular gas path, and no air pipe is required. Adjust the air pressure when working, and blow away the waste chips while cutting and exhausting through the air inlet and outlet.

The advantage of the workbench design is that the entire chip removal system can be modified by adding a chip removal table without modifying the machine tool, so as to improve the chip removal efficiency of the machine tool. When cutting machine work, on the one hand making the aluminum chip high efficiency into the system of the removal of the chip, before aluminum chip splash on the workbench. On the other hand the aluminum scraps of residual splashing on the table triangular groove rely on pneumatic blowing into the cutting seam, in the high-speed rotation of the cutting teeth to drive aluminum chips. The design drawback is that the design of the table shape and the design of the cutting seam has a certain complexity, but according to the current domestic processing equipment, it can be achieved.

Acknowledgments
This research was financially supported by The construction and research of the "3+4" cooperative training system for vocational education-taking the electromechanical profession as an example (SGJGB0101) and the exploration of the research and management concept of industrial robot laboratory construction (JG20180501).
References
[1] Jianqiang Ding, Xiao Ren, Yaping Lu: Computer Control Technology and Application (Second Edition), Qinghua University Press, 2017
[2] Yaping Lu, Tianlin Song: algorithm and implementation of digital PID based on MCGS-DDC. Information technology and computer application engineering (ITCAE2013), CRC Press (2014), Pages 131–134
[3] Yaping Lu, Tianlin Song: influence of silicon controlled rectifier voltage regulation device under DDC-temperature control. Mechatronics and intelligent materials (MIM 2013), AMM Press (2013), Pages 826–829
[4] Xiaolu Tang, Yapin Lu: The design of regional environmental monitoring system based on labview, Environment, Energy and Applied Technology, Taiwan, 2015, CRC Press Taylor & Francis Group publisher, Pages 83–86
[5] Chen Da, Yapin Lu, Min Hu: The design of environmental monitoring system based on STC single chip microcomputer, Environment, Energy and Applied Technology, Taiwan, 2015, CRC Press Taylor & Francis Group publisher, Pages 401–404