The Research and Design of the Automotive Radiator Production Line

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Abstract. Automotive radiator is one of the important parts of the automobile manufacturing. However, in China domestic enterprises lack the capacity of independent production. To solve this problem, based on the process analysis of the automotive radiator, the composition of the automotive radiator production line is analyzed, and then an automotive radiator production line to produce the highly-efficient, thin-walled aluminum automotive radiator. Meanwhile, the operation flow and the characteristics of the production line are elaborated. The practice shows that the production efficiency and quality of radiating pipe has been greatly improved using this automotive radiator production line.

Introduction

Radiator is an important component part of automobile engine cooling system and serves a very important role in an automobile. It dissipates the waste heat generated after the combustion process and useful work has been done. The performance of the radiator directly affects automobile engines [1, 2]. Nowadays with the increasingly market competition and the rapid development of automobile industry in China, the demand for automotive radiator parts grows continuously. However, it shows that domestic enterprises engaged in automobile radiator production are very few, only about 100, according to the China Internal Combustion Engine Industry Yearbook [3]. Most of them are small and weak in technology and research. In general, they just buy parts and assemble them together, thus they lack the capacity of independent production. There is still a large gap between the domestic radiator industry and the international advanced industry. The gap mainly lies on the thermal performance of the products, the automaticity of production line and the utilization of raw materials etc. [4, 5]. To change the backward status of automobile industry and adapt to the rapid development of the automobile industry in China, it is very urgent to construct the automotive radiator production line to produce the highly-efficient, thin-walled aluminum automotive radiator.

The remainder of the paper is organized as follows. By analyzing the production process of the highly-efficient, thin-walled aluminum automotive radiator, Section 2 introduces the composition of the automotive radiator production line. In Section 3, the layout of the automotive radiator production line is illustrated with the line production process; the operation flow of the production line designed is pointed out. Finally, the conclusion is offered in Section 4.
Composition Analysis of the Automotive Radiator Production Line

Process of the Automotive Radiator

The automotive radiator production line is to produce the highly-efficient, thin-walled and shaped aluminum radiating pipe. One type of the radiating pipe is shown in Fig.1. It is the rectangular aluminum radiating pipe used in the intercooler. In this figure, 1 is the two fillet transitions, 2 is the two edges of the welding, 3 is the edge of pipe, 4 is the two long edges of the pipe, 5 is the another two fillet transitions, 6 is the weld. The forming process of the pipe is shown in Fig.2.

![Figure 1. Rectangular Aluminum Radiating Pipe Schematic Diagram.](image)

Note: (a) Transverse section of aluminum strip; (b) The final transverse section of the first deformation stage; (c) The final transverse section of the second deformation stage; (d) The final transverse section of the third deformation stage; (e) The final transverse section of the fourth deformation stage.

Figure 2. Transverse Sections of Different Pipe Welding Deformation Stages.

The automotive radiator production line is to produce the radiating pipe continuously. It continuously delivers aluminum and aluminum alloy strips of a certain width and thickness to the main production system by vertical transportation equipment which stores materials. In the main production system, the aluminum and aluminum alloy strips are made into a variety of rectangular pipes or shaped pipes by the crude cold-formed molding, precision molding, and high-frequency induction welding. And then after weld burr removal, weld quality online testing, sizing, finishing and shears, they are made into various automotive heat exchanger parts with different cross-sectional shapes and different lengths. Its basic production process of aluminum radiating pipe is as shown in Fig.3.

![Figure 3. Production Process of the Automotive Radiator.](image)
Composition of the Automotive Radiator Production Line

According to the production process of the automotive radiator, the different series of aluminum coil will be continuous formed, welded, tested, and then cut to size various automotive radiator, so the composition of the production line must contain four sub-system, namely the aggregate-storing system, the processing system, the conveying system and the control system. The processing system is mainly to finish the rough-shaping, precision shaping, high frequency welding, cooling, removing burrs, eddy current testing, measuring, finishing and flying shear. The whole production line involves mechanical, electrical, control, material, welding, testing, mold, hydraulic, pneumatic, computer, multidisciplinary and other related technologies in the field of advanced manufacturing integrated system, and its composition is shown in Fig.4.

Design of Automotive Radiator Production Line

Layout of the Production Line

According to the production process of the automotive radiator and the composition of the production line, the whole production line is set up as is shown in Fig.5. The aggregate-storing system contains the double uncoiling machines, the belt receiving machine, the vertical belt storage loop and tension-eliminating loop. The main processing system includes the rough-shaping, precision shaping device, the solid-state high-frequency induction welding equipment, the burr removal equipment, the eddy current inspection, the finishing machine, the speed/length measuring device and flying shear.

Figure 4. Composition of the Automotive Radiator Production Line.

Figure 5. Schematic Diagram of the Automotive Radiator Production Line.
Operation Flow and Characteristics of the Production Line

In the production line, aluminum is formed directly from belt to rectangular or irregular cross-section shape; the operation flow of the production line is shown in Fig.6.

![Operation Flow of the Production Line](image)

The designed automotive radiator production line has its own characteristics and merits.

1) It uses the method of combining Downhill forming and Constant bottom line finishing to guarantee the uniform deformation. This method has several advantages, for example, small area of deformation, high accuracy of finishing and short size of equipment. Besides, the overall deformation process is simple, the path of processing is brief and the number of deformation roller units is small.

2) Solid High Frequency Induction Welding Technology is applied to welding the radiating tube of the equipment with the features like high speed, stable quality, simple crafts, low cost and economic investment. For matching outputs with load automatically, high frequency induction welding device is provided with automatic Velocity-Power Control System.

3) This equipment utilizes double uncoiling units, movable sleeve for storing and ultrasonic aluminum welding machine to realize continue working of main engine, which can reduce auxiliary working hours and improve the production efficiency of the equipment.

4) The production line is equipped with Online Eddy Current Testing, thus welding quality can be detected real-timely and be evaluated whether it’s qualified, and the selection device can be controlled by this equipment.
5) Furthermore, Online Servo Flying Shear is used in this line, which can guarantee that the cutting process is accuracy with high speed continuously.

Conclusions

According to characteristics of the aluminous welded pipe and its process, based on the composition analysis of the automotive radiator production line, an automotive radiator production line is designed to produce the highly-efficient, thin-walled and shaped aluminum radiating pipe. Then the operation flow and characteristics of the production line are elaborated. This designed production line has been put into use in Shandong Houfeng Auto Radiator Co., Ltd, and it can be used to produce 5 series of radiating pipe, i.e. 14 varieties of radiating pipe. It has been proved that the production efficiency and quality of radiating pipe has been greatly improved.

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