

Research on the Automation Scheme of Slide Valve Production Line

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Abstract

As an important part of railway train, the performance of braking system directly affects the safety of transportation. In the brake system, the slide valve, as an important basic component, is also the brake switch. The quality of the slide valve directly affects the reliability and stability of the main valve. In this paper, aiming at the existing slide valve machining process and equipment, we will improve the processing technology, introduce automatic equipment, break the existing equipment layout, and establish an automatic production line. In order to improve the quality of slide valve products, improve production capacity, and eliminate the phenomenon of batch waste products; at the same time, reduce the number of products in process, reduce the labor volume and potential safety hazards in the production process, and then improve production efficiency to meet the requirements of lean concept.

Keywords

slide valve; process; lean.

1. Introduction

With the continuous development of heavy load and high speed of railway freight cars and the change of railway transportation mode in China, the reliability of braking technology is required to be higher [1-2]. As the core part of the main valve, the quality of the slide valve directly affects the reliability and stability of the main valve[3]. Since the mass production of slide valve, the processing of its overall dimension is basically completed by the ordinary horizontal milling machine. Due to the low degree of automation of processing equipment, there are many process divisions (13), many times of sequence transfer (11), long manufacturing cycle and low monthly output. At present, the processing technology of slide valve has the disadvantages of low processing efficiency, long manufacturing cycle and large quantity of in-process products, which can not meet the requirements of production and manufacturing cost. Therefore, it is necessary to design a new process for the machining of the existing slide valve.

In this paper, aiming at the existing slide valve machining process and equipment, we will improve the processing technology, introduce automatic equipment, break the existing equipment layout, and establish an automatic production line. In order to improve the quality of slide valve products, improve the production capacity, and eliminate the phenomenon of batch waste products; at the same time, reduce the number of products in process, reduce the labor volume and potential safety hazards in the production process, so as to achieve the purpose of improving production efficiency.

2. Slide Valve Structure and Braking Principle

The arrangement of control valve, slide valve and through-hole and groove on slide valve seat of valve 120 is shown in Figure 1. In the figure, the slide valve shows its back (i.e. top surface, the plane that fits the control valve) and bottom surface. When the main piston moves

downward or upward due to the pressure difference on both sides, it moves with the control valve relative to the slide valve and with the slide valve relative to the slide valve seat, respectively, making the slide valve and the slide valve seat as well as the relevant channels on the back of the control valve and the slide valve connected or cut off, thus producing the functions of inflation, release, local reduction, braking and pressure maintaining.

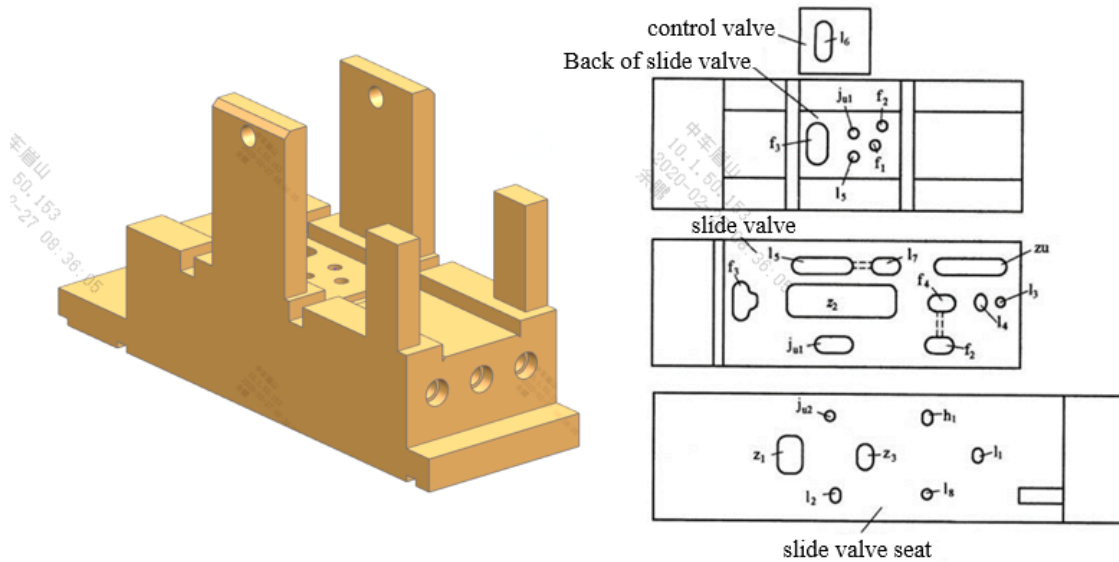


Fig. 1 Structure diagram of 120 slide valve

3. Current Slide Valve Production Process

The slide valve is a representative product of the brake company. At present, the slide valve production line has completed all the processing contents of the slide valve from the blank to the finished product, with 13 processes and 7 working positions, mainly including milling surface, milling groove, drilling, welding, etc.; there are 15 sets of equipment, mainly including drilling and milling center, processing center, numerical control milling machine, etc.

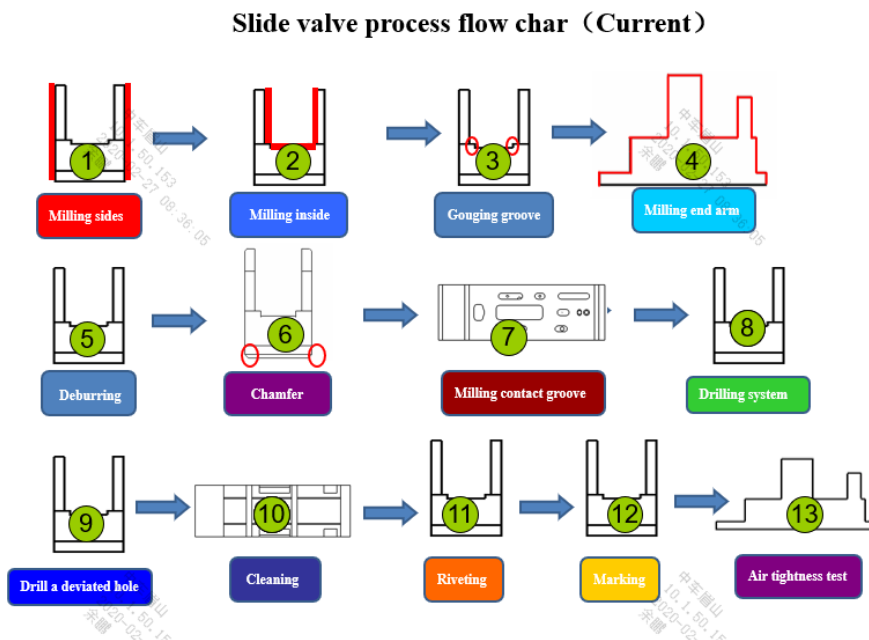


Fig. 2 Current slide valve process flow chart

At present, there are some problems in the machining process of slide valve. As shown in Fig. 2, the processing of slide valve's milling inner side, milling end arm and oil slicing groove is carried out with different equipment, which is divided into three processes, with low processing efficiency. The burr is cleaned manually. The riveting and welding process is all completed by manual operation. The production efficiency is low, the working procedure is long, the labor intensity is high, and the number of work-piece transfer is large. As a result, the manufacturing cycle of the slide valve is long, the number of products in process is large, and the labor intensity is large. The most fundamental reason for these problems is that there are too many machining procedures. To solve this problem, we should reduce the number of processes and adopt the way of process concentration.

In conclusion, at present, the processing technology of slide valve has some disadvantages, such as low processing efficiency, long manufacturing cycle, large quantity of products in process and large capital occupation, which can not meet the requirements of production and manufacturing cost. Therefore, it is necessary to design a new process for the machining of the existing slide valve.

4. Content of New Process Plan

4.1. Programme Objectives

(1) Production capacity: 3200 pieces / month (22 working days), production program reaches 3000 pieces / month.

(2) Optimize the process method, reduce the process flow, and realize single operation. Improve the processing efficiency by 30%, reduce the manufacturing cost, reduce the number of processes by 30%, and significantly reduce the labor intensity.

(3) Set up unit flow type automatic production line. Break the existing equipment layout mode, establish the unit production line according to the technological process, and shorten the logistics distance by 20%;

(4) Implement the mode of "one person, multiple machines, rhythmic production", eliminate the excessive production of the previous process, implement the mode of single piece flow, and speed up the turnover of workpieces. Reduce the number of products in process by more than 50%, and control the manufacturing cycle within 1 day;

(5) Improve product quality, put an end to the phenomenon of batch waste products, and reduce the size dispersion.

4.2. Content of the Plan

To achieve the above goals, we need to improve the processing technology, production operations, equipment layout and other aspects[4].

4.3. Process Optimization

4.3.1. Reducing the Number of Processes for Processing the Overall Dimension of Slide Valve.

After the horizontal machining center is adopted, the processing content that needs 4 processes to be completed in the ordinary horizontal milling machine can be shortened to 2 processes and 1 equipment can be completed. Two slide valves are used as a group each time, and the existing ordinary vice is equipped with a special jaw for positioning and clamping once for processing. When the equipment is put into use, it will directly eliminate the previous disadvantages, have the conditions of single piece to sequence, can accelerate the flow of workpieces, shorten the manufacturing cycle, reduce the auxiliary time, and will greatly reduce the number of working procedures in production.

4.3.2. Improve the Machining Efficiency of Milling Inner Side, Milling End Arm and Oil Groove

At present, horizontal milling machine is used for milling the inner side of slide valve, planer for oil groove and horizontal CNC milling machine for milling the end arm. Three equipment are used to complete the milling process in three steps, with low processing efficiency. Horizontal machining center can be used for one-time processing. With this method, the processing time of each piece is reduced from 4.5min to 2.5min, and the efficiency is increased by 56%. According to the production program (4000 pieces), 3333 yuan (2x4000 / 60x25) can be saved every month.

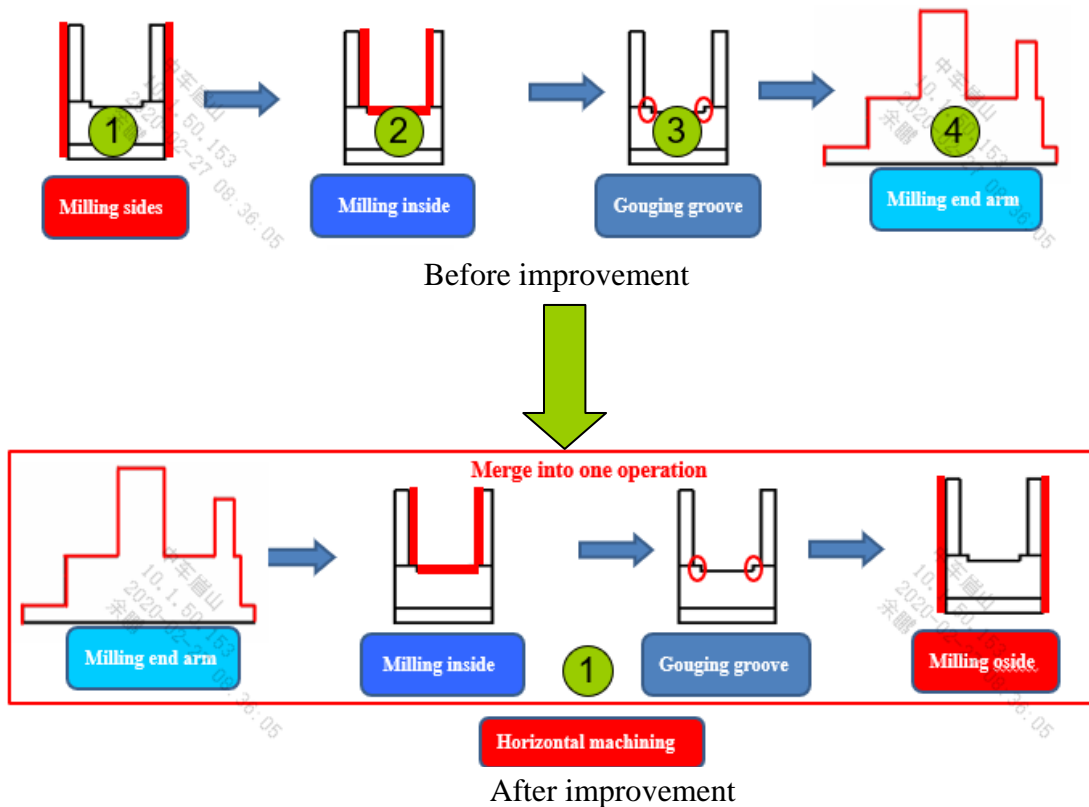


Fig. 3 Improvement comparison

4.3.3. Optimize Deburring Process

According to the special structure, processing technology, cleaning effect, equipment efficiency and economic profit of the slide valve, the method of burr removal by high-pressure water jet will be adopted[5]. Figure 4 shows a high-pressure cleaner.



Fig. 4 A high pressure cleaner

4.4. Process Reengineering

Through the above process optimization, the number of processes is greatly reduced, and the single machine single process processing is realized, which lays the foundation for the establishment of the unit beat type automatic production[6].

Slide valve process flow char (Improvement)

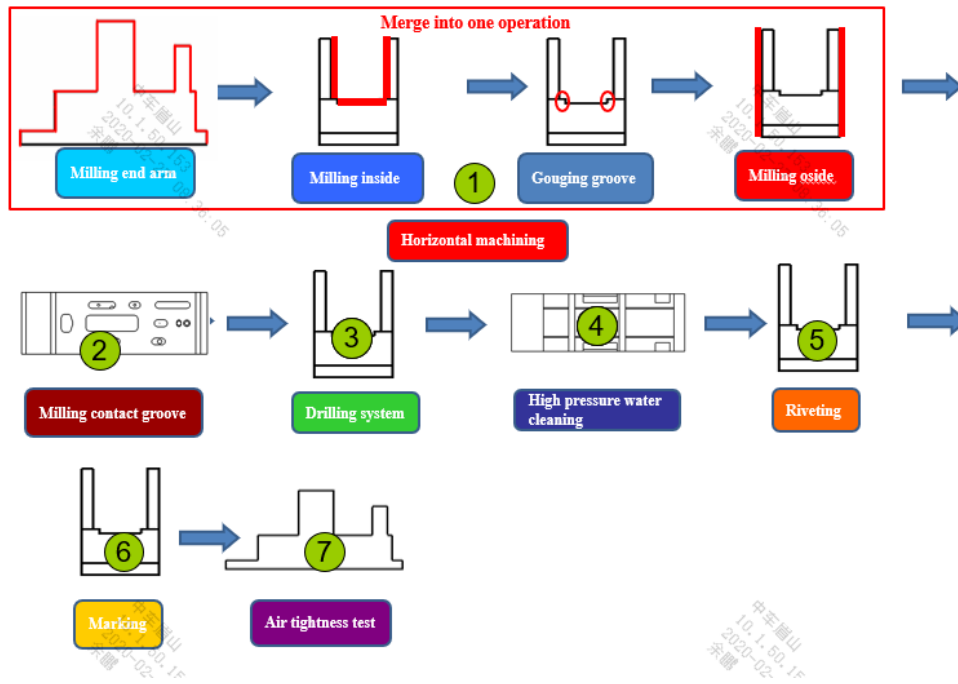
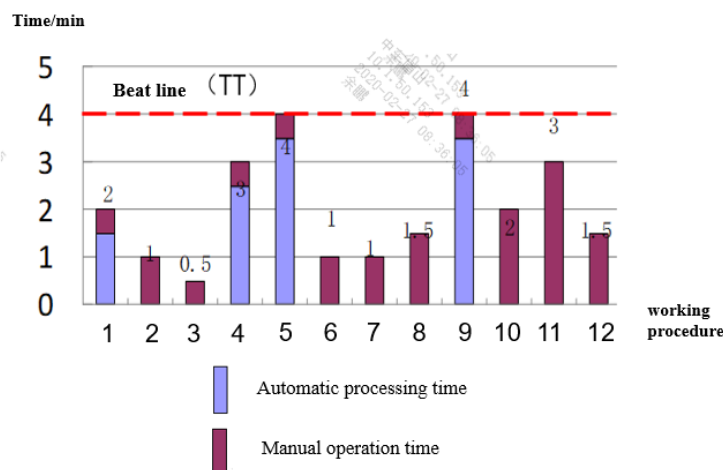


Fig 5. Optimized process flow

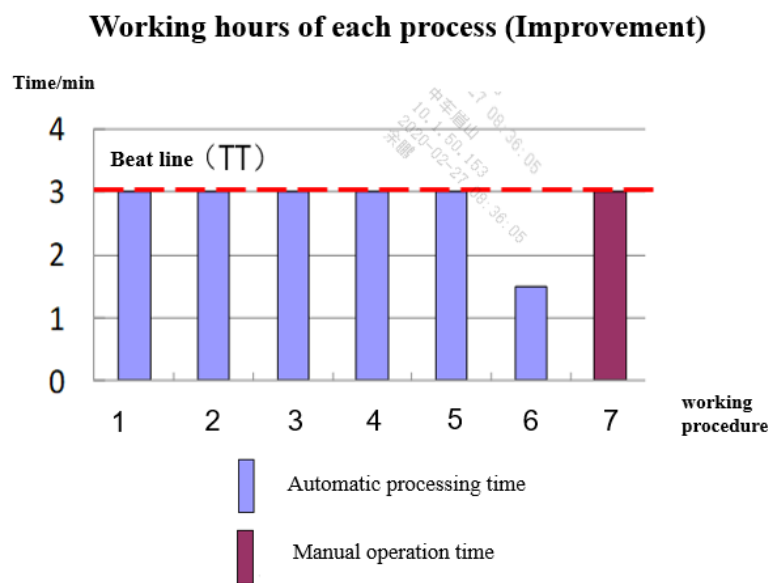
4.5. Production Capacity Accounting

According to the above process flow and equipment configuration, calculate the processing time of each process. According to this data, we can get: the daily production quantity is 220, the monthly production quantity is 4840 (22 days), and the bottleneck process is a combined process (two shift system). Figure 6 shows the processing time of each piece after optimization and at present.

Working hours of each process (Current)



(a)



(b)

Fig 6. Process processing time comparison

It can be seen from the comparison of the above two figures that the processing time of each slide valve in the new process is 19.5min, which is 10min less than the current process of 29.5min, in which the time of each manual operation is reduced by 8min, which significantly reduces the labor intensity.

4.6. Equipment Layout

Due to the influence of mass production mode and the pursuit of equipment operation rate, most of our machine tools adopt cluster layout[7]. At present, the slide valve is produced on such equipment layout.

With the change of market form, this layout reflects the limitations of its era, and there are many waste phenomena, such as long manufacturing cycle, unclear logistics route, large distance, backflow and other issues. This mass production mode is increasingly unable to meet the market demand. Only by breaking the existing equipment layout, according to the product process to carry out scientific equipment layout can these problems be avoided. According to the current situation, the equipment layout can be adjusted according to the following scheme.

The above equipment layout is a processing and production unit formed according to the process flow. The general idea is: the arrangement of equipment is conducive to one person and multiple machines operation, material flow, human flow and information transmission, with the least waste. The main features are as follows: (1) the rough and finished products are on one side, which can be operated by one person. It is better to control the process in quantity. (2) It is conducive to the cooperation of operators. (3) The operator's logistics route is short. Each cycle distance of the operator is about 5 meters. According to the production of 220 pieces, the daily walking distance is 1100 meters. (4) In horizontal machining process, setting 2 machining centers will effectively reduce the number of workpiece clamping and sequence switching.

After the equipment layout and production beat are determined, in order to eliminate waste such as waiting, large quantity of products in process and long manufacturing cycle, it is necessary to scientifically and reasonably combine the operations of each process, implement one person and multiple machines (person on and machine off) to eliminate excessive

production, minimize the quantity of products in process, shorten the manufacturing cycle and improve the effective operation time.

5. Results and Conclusions

Table 1. Comparison before and after improvement in various aspects

	personnel	Processing time (min)	goods-in-process	Occupation of funds(Yuan)	Process number	Clamping times
Before improvement	7	29.5	3960	142,560	13	19
After improvement	3	19.5	4840	3672	7	12

(1) Production capacity: 4840 pieces / month (22 working days), production program reaches 3000 pieces / month.

(2) Optimize the process method, reduce the process flow, and realize single operation. Improve the processing efficiency by 33.8%, reduce the manufacturing cost, reduce the number of processes by 36.8%, and significantly reduce the labor intensity.

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