

Innovation Design of Train Water Feeder based on Ergonomics

Xiaoye Wang, Jiangxu Hao, Wenting Xu, Zhihan Li, Dongfeng Huo

Baoji University of Arts and Sciences, Baoji 721007, Shaanxi, China

Abstract

Objective— to save water resource, increase feeding water efficiency and prevent occupational diseases. **Methods**— designing a new product based on ergonomics principles. **Results**— reduce the water labor and prevent their occupational disease; Save water resource; enhance the efficiency of feeding water to ensure the water supply of trains; improve the operation environment of the workers. **Conclusion**— the water feeder is a real innovation product.

Keywords

Ergonomics, Train Water Feeder, Innovation Design, Occupational disease, Efficiency.

1. Introduction

With the improvement of economy, people have more choices to vehicles when they go out, but ordinary train still accounts for a large market share [1, 2]. The train will quickly water supply by water labor to facilitate water to follow-up the schedule of travellers when it arrive at each station in the process of marching. The train requires feeding water efficiency is very high because it standing just a few minutes. Not only water labor walking speed but also feeding water operation proficiency has influence on the efficiency of the water. The feeding water plays important roles to improve the efficiency of water and the prevention of occupational diseases. In this paper, we design a water feeder according to principle and method of ergonomics. It has important significance to improve the efficiency of feeding water and the effective prevention of water labor occupational disease

2. The problems of train water process

Because feeding water process cannot mechanized operation, the train arrive at the station every time, the water labor are strictly abide by a set of feeding water application: to the line—open water valve— insert the pipe—feeding water—unplug the pipe—close the valve—the pipe back iron groove. As shown in figure 1 is ordinary train feeding water intake with vertical downward, water injection pipe is a common rubber hoses of about 25 meter long. It is need to pinch the pipe orifice in the process of ran to the water injection and end feeding water ran back to water plug when opening valve and the workers need to bending and holding the pipe in the process of feeding water, otherwise the pipe fall off easily. The work's workload is great, because they walk more than 20 kilometers on foot for feeding water more than 360 trains about 6000 railway carriage in a small space every day. Therefore, the current process of water not only caused the waste of water resources but also brought a lot of occupational disease to water labor, at the same time, it come into being the working environment of “Summer in mud from head to foot, a suit of ice in winter” [3].



Fig.1 Ordinary train feeding water scene

3. The train water feeder design based on ergonomics

It is be study of interaction of human - machine - environment in all kinds of work environment and consider coordination problems about the health, safety, comfort, efficiency in the life and work in the ergonomics. As water feeder, it contact with the workers in a long time. It will cause the occurrence of occupational diseases and reduce the efficiency of feeding water, at the same time it will lead to the passengers’ travel inconvenience if the design of water feeder is unreasonable [4-6].

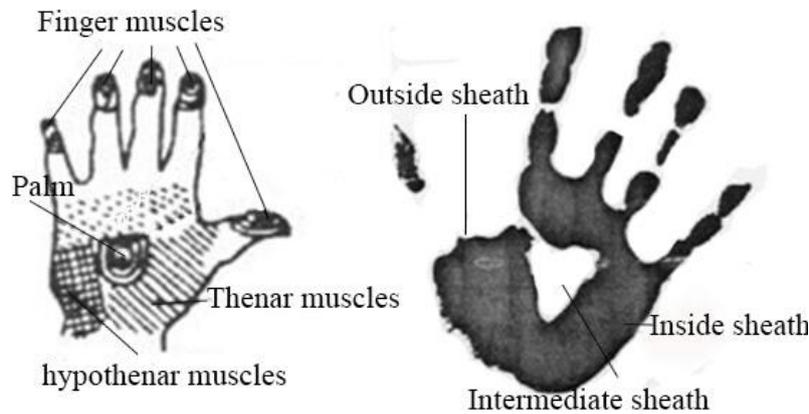


Fig.2 Hand chart

As shown in figure 2 is the palm structure diagrams. Water feeder apparatus as hand tools, the design should base on the following article of ergonomics.

- 1) Operating activities should be completed in the best activities scope of the hands;
- 2) Avoid local fatigue when repeat operations;
- 3) Avoid static power works;
- 4) The tools handle shape can’t fit the palms to avoid palm tissue compression;
- 5) Avoid unreasonable operation posture.

4. The thinking and principle of train water feeder innovative design

Aiming at the problems existing in the process of feeding water, water feeder is design from the following aspects according to ergonomics principle:

4.1 Water feeder appearance

4.1.1 The water feeder handle length design

Table 1 is hand sizes of 18 to 55 years male and female [7].

Table.1 Hand size of 18 to 55 years old male and female (mm)

Percentile		1	5	15	50	90	95	99
4.6.1 hand length	Male	164	170	173	183	193	196	202
	Female	154	159	161	172	180	183	189
4.6.2 Hand wide	Male	73	76	77	82	87	89	91
	Female	67	70	71	76	80	82	84

Water feeder is II A type product design (large size). According to design requirements of II A type product, the dimension of the 99th percentile male palm width as a design basis, as follows:

$$P99=91\text{mm} \tag{1}$$

Water feeder length is double because of 2 hands are need in the process of inserted into the pipe:

$$91 \times 2 = 182\text{mm} \tag{2}$$

Considering easy to grasp on working, dynamic correction size setting of 38 mm, so the length of handle parts:

$$L=220\text{mm} \quad (3)$$

4.1.2 The water feeder handle diameter design

Water feeder is gripping tool, it is more appropriate that the diameter value 30 -40 mm based on experience. It value of 35 mm considering both men and women;

4.1.3 The water feeder handle surface treatment

Handle adopts the knurled surface treatment in order to prevent slide and increase the friction when inserted into the injection port and commute from hands.

Considering the processing cost, the handle shape is simple column.

4.2 Buckle structure design of water feeder

It caused local static force on their hands because of water labor holding pipe to prevent slide in the process of feeding water. From figure 1, It be seen that their operation position is unreasonable, it will bring to their occupational disease, and the water out once the pipe sliding, not only waste water but also worsen their work environment. Therefore, buckle structure is designed according to tribology principles. It is shown in figure 3. Water feeder buckle against the outer wall of water injection pipe under the action of gravity, the structural design liberated workers hands and prevent the water pipe sliding in the process of feeding water.

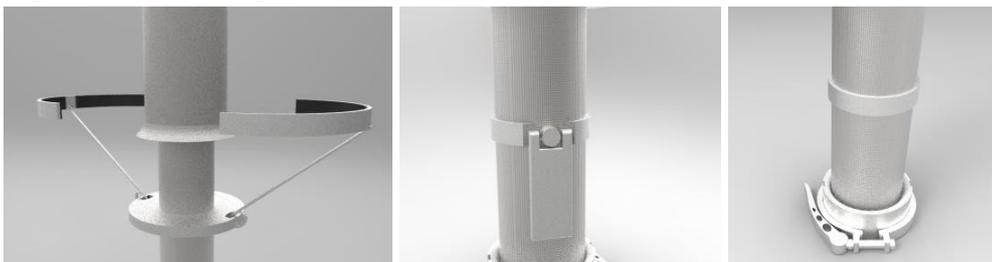


Fig.3 Buckle structure

Fig.4 Switch structure

Fig.5 Connecting structure

4.3 Switch structure design

The figure 4 is switch structure. It is very good to avoid pinch the pipe head and water flow out when ran to the water station and ran back to water plug. Round plate's diameter is equal to inner diameter of water pipe. Water is shut down when round plate and handle coaxial parallel direction and water is open when their axis direction is vertical. The structure is very good for water free switch, saving water resources.

4.4 Connecting structure of water feeder with rubber pipe

As shown in figure 5 is connecting structure of water feeder with rubber pipe, this device can prevent shedding of rubber hose, also easy to replace rubber hose. Figure 6 is water feeder and figure 7 is assembly drawing.



Fig.6 Water feeder

Fig.7 Assembly drawing

5. Conclusion

In this paper, we designed a water feeder, it changes the water labor operating state and working condition, reduce workload of works, prevention their occupational disease, save water resource and improve the efficiency of the feeding water to ensure the maximum common water supply in the train. Therefore, it is a truly innovative product.

Acknowledgments

This paper was supported by National Natural Science Foundation of China (No.11302003); Project of Education Department of Shaanxi Provincial Government(No.16JK1041); Start-up Project of Dr. of Baoji University of Arts and Technology (No.ZK16043); Project of Innovation and Entrepreneurship of Shaanxi University Students(2015dc32).

References

- [1] J.H.He:Traffic Information Service under the Condition of Travel Mode Choice Analysis, Automation and Instrumentation, (2016) No. 11, p. 112-114.
- [2] K.Meng, L.Li: Based on the Ergonomics of the Civil Aviation back Structure Design and Optimization ,Journal of Luoyang Normal College, Vol. 35 (2016) No. 8, p. 35-38.
- [3] G.S. Chen: Existing Problems of Water Supply System and Reforming Advice,Journal of Gansu Science and Technology, Vol. 25 (2009) No. 3, p. 63-65.
- [4] C.R. Liu: *The Man-Machine Engineering Application* (Shanghai people's arts publisher, China 2009), p. 13-14.
- [5] X.Y.Xu: Industrial Vehicle Cab Design based on Ergonomics Research,Journal of Product Design and Theory, (2012) No. 3, p. 57-64.
- [6] F.T. Zhang: The Man-Machine Relationship Study of Handheld Tools, Journal of Guangxi Light Industry, Vol. 144 (2010) No. 11, p. 60-61.
- [7] H. Liu: *Based on the Ergonomics of the Multi-functional Stroller Design* (Ph.D., north China electric power university, China 2013), p.13.