



A New Structural Door of Box Type Heating Furnace

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Abstract. Box-type heat treatment furnace is the most common heating tool in the thermoforming industry, which can convert electric energy or natural gas into heat energy to evenly heat materials to a certain temperature. After many years of development, the relevant technology of box-type heating furnace has reached the bottleneck period, and many shortcomings have been exposed in the process of use. Solving these problems has obviously become the key to the progress of thermoforming. Therefore, this paper proposes a new type of box type furnace door structure, which can effectively improve the high energy consumption of box type heating furnace by changing the opening mode of furnace door to improve the energy utilization rate.

Keywords: Box-type heating furnace · Furnace door · Hot stamping

1 Introduction

In the context of the rapid development of the automotive industry, people pay more and more attention to reducing the weight of the car body and improving the strength of the car body. In order to accommodate this development trend, high-strength steel sheet metal parts are more and more used in car body parts. At the same time, the forming of high-strength steel parts is a key technical difficulty faced by technicians. Therefore, the hot forming technology of high-strength steel parts came into being [1].

The main processes of hot forming of high-strength steel are: blanking - heating and austenitization - stamping - cooling and quenching - opening die and parts taking. Among them, austenitizing and cooling quenching are main factors for affecting the performance of parts [1].

At present, high-strength steel plates are mainly heated and austenitized in heating furnaces. There are two structural forms of heating furnace: box heating furnace and roller hearth furnace. Roller hearth furnace has the advantages of saving transfer time, low investment cost and easy operation, but it also has the shortage of large floor area [2]. The box type heating furnace has minimal requirements for space and has many applications in practical applications [3].

In this paper, through the structural analysis of the box heating furnace, the problems and reasons that have always existed in its use are emphasized. Finally, a new type of box furnace door structure is proposed, which has the advantages of short opening time, small thermal deformation, good heat preservation and so on.

2 Structure Introduction and Disadvantages of Box Heating Furnace

The box heating furnace is composed of furnace shell, furnace lining, furnace door, opening mechanism and heating system, atmosphere protection system and control system. Among them, the furnace shell, furnace lining and furnace door are important factors for the insulation performance of the box furnace. If the insulation is not done well in the manufacturing process, the energy dissipation will be particularly serious during use, and the furnace surface will have an obvious intense burning feeling [4].

When the box furnace is used for the heating process, the sheet metal is transferred to the furnace. After the heating of the sheet metal is completed, it is necessary to open the door for reclaiming, and the manipulator extends into the furnace to grasp and transfer the sheet metal. In this process, the opening height of the furnace door is large, and the heat in the furnace door dissipates rapidly. In a very short time, the temperature in the furnace will drop by dozens of degrees. It is necessary to quickly increase the temperature in the furnace through the heating system after closing the furnace door. Therefore, compared with the roller hearth furnace, the energy consumption of the box heating furnace is very high, and the energy utilization rate is also lower [5].

In addition, the door of the box heating furnace is composed of a metal shell, a moving mechanism and thermal insulation materials. When the door is opened, there will be a lot of heat to bake the door. Even the heat-resistant metal, metal shell and motion mechanism will deform under long-term baking, resulting in the furnace door can not be completely closed, resulting in serious heat loss and increased energy consumption. So, overcoming the deformation of box-type furnace door is also the key to improve insulation performance. Therefore, we proposed a new structural furnace door to solve these problems.

3 New Structural Furnace Door

The new structural door of box-type furnace was shown in Fig. 1 and Fig. 2. It is composed of an active mechanism, insulation modules, shade cap, connecting shaft and a slave mechanism. The furnace door is driven by the servo motor to open obliquely upward, and the left and right racks are fixed by the connecting shaft, so as to achieve the synchronous state of left and right opening. The opening speed is about 1 s, which is fast 40% than the traditional furnace door.

The furnace door insulation module adopts a segmented structure to offset the deformation caused by thermal expansion. When the furnace door is open, the shade cap on the front of the furnace door can prevent heat from diffusing upward to the surface of the furnace body and reduce thermal deformation. Therefore, the sealing effect of the furnace door is good, the heat is not easy to lose, and then the uniformity of the furnace temperature is delightful, and the energy consumption is lower.

In order to prevent the thermal deformation of the connecting shaft of the furnace door, the connecting shaft of the furnace door is installed inside the cooling water pipe, and the thermal creep problem is solved by supplying sufficient cooling water to ensure the strength of the shaft body. The two ends of the shaft are connected with the gear

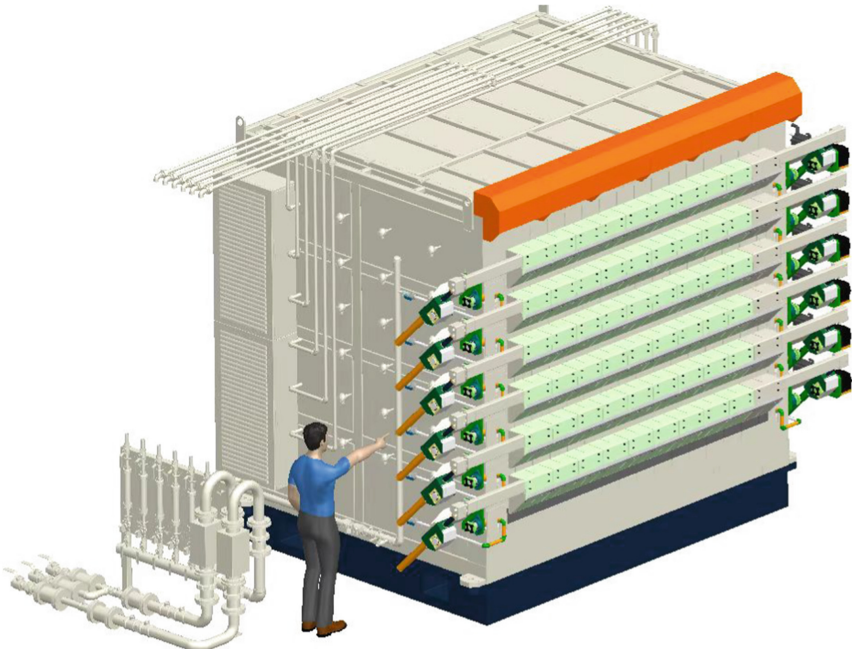


Fig. 1. The box-type heating furnace.

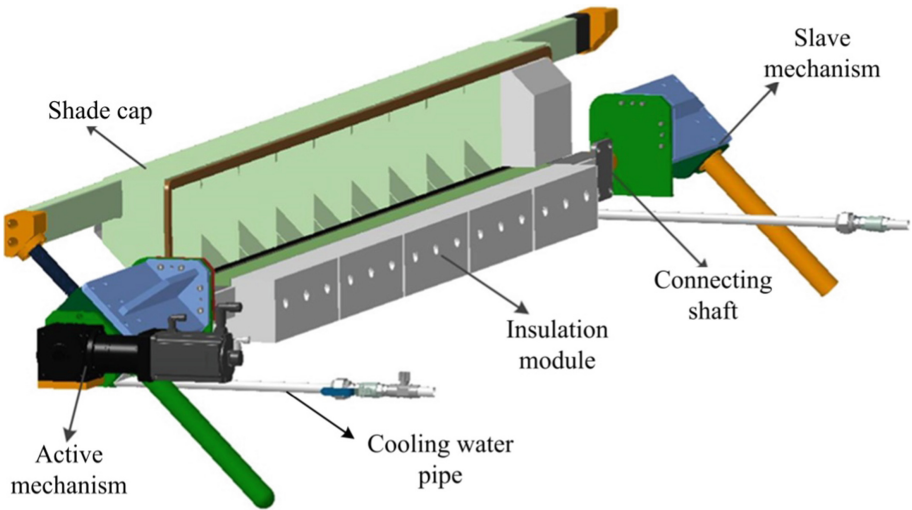


Fig. 2. The new structural furnace door.

part through the coupling, which eliminates the problem of shaft misalignment caused by insufficient accuracy during assembly.

4 Conclusion

The new structural furnace door has the following advantages:

- (1) The new structural furnace door overcomes the problem of thermal deformation. The furnace door frame adopts a heat-resistant metal structure, and the strength of the frame is improved by adding stiffeners inside. By setting segmentation and shielding thermal radiation, the sealing effect is good and the energy utilization rate is improved.
- (2) The new furnace door adopts the opening mode of upward rotation, with fast opening speed and less heat loss.

References

1. H. Karbasian and A. E. Tekkaya, A review on hot stamping. *J. Mater. Process. Tech.* **210**, 2103 (2010).
2. N. Zhonga, X. D. Wang, L. Wang and Y. H. Rong, Enhancement of the mechanical properties of a Nb-microalloyed advanced high-strength steel treated by quenching partitioning tempering process, *Mat. Sci. Eng. A* **506**, 111 (2009).
3. J. P. Lin, L. Y. Wang and H. B. Tian, Research and progress of hot stamping of ultrahigh strength steel. *Hot Working Tech.* **37**, 140 (2008).
4. J. Lechler, M. Merklein and M. Geiger, Determination of thermal and mechanical material properties of ultra-high strength steels for hot stamping, *Steel Res. Int.* **79**, 98 (2008).
5. L. G. Aranda, Y. Chastel and J. F. Pascual, Experiment and simulation of hot stamping of quenchable steels, *Adv. Technol. of Plasticity* **2**, 1135 (2002).

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