Coating Application of Heat-resistant Cast Steel Turbine Shell

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Abstract
This article introduces the common casting defects of heat-resistant steel turbine shells. The causes of black spots and slag inclusion defects are analyzed using Sigma 300 scanning electron microscope, AZtecX-Max20 energy spectrometer, and X-ray fluorescence analyzer (XRF). A new zircon water-based coating (105KH coating) is used to solve the defect of coating peeling off in the inner cavity of the flow channel; the new composite water-based thermal insulation coating (857 coating) is used to solve the black spots and cold isolation defects within the inner cavity of the three-channel turbine shell, while ensuring that the inner cavity is free of defects such as sand and pores.

Keywords: turbine shell； heat-resistant cast steel； black spots； zircon coating； thermal insulation coating

1 Introduction
This article discusses common casting defects in heat-resistant steel turbine casings. The pouring temperature of heat-resistant steel is relatively high, sometimes as high as 1650°C (or even higher). Choosing appropriate coatings can effectively eliminate sand sticking, reduce surface pores and wrinkles, improve the surface finish of castings, and reduce inclusions and inclusions caused by coating peeling. Defects such as leakage [2]. At present, the domestic coatings used for heat-resistant steel turbine shells are mainly zircon powder or zircon powder composite coatings. However, in actual production, it is found that zircon powder coatings have problems with cold isolation at the end of the flow channel when producing complex three-channel turbine shell castings, the defect of the inner cavity coating falling off, and a small number of pore defects.

In response to these problems, our company has developed a new type of zircon powder water-based coating (105 KH coating), which solves the problem of coating peeling off in the inner cavity of the flow channel. The new composite water-based thermal insulation coating (857 coating) is used to solve the black spots and cold insulation defects in the inner cavity of the three-flow turbine shell, while ensuring that the inner cavity is free of defects such as sand sticking and pores. After production practice, the appearance and flow channel can meet customer requirements.

2 Experimental procedure
Water-based 105 KH paint trial process

To solve the problem of coating peeling, 105KH coating is used. This paint is white in color and has no pungent smell. After the paint is diluted and stirred, no bubbles are visible in the paint tank, and the defoaming property is very good. The paint is diluted with water to a Baume degree of 63 to 66 Bé and dip-coated. The dip-coating performance is excellent. The coating on the surface of the flow channel core has good coverage without any undesirable problems such as water breaks, bubbles, and flow marks (see Figure 1). After drying, the cross-section of the sand core was observed. The coating penetrated evenly and the coating penetration depth was 1.40-1.60 mm (see Figure 2), which is higher than that of workshop coating B. The wet thickness of the coating is 175~200 μm.

Fig. 1. Surface after drying

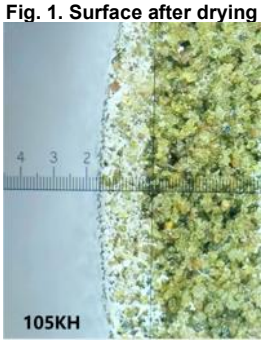

Fig. 2.Penetration depth

Water-based 105 KH paint trial results
The workshop uses B paint for normal production. After shakeout, the castings have a certain proportion of coating peeling defects following shot blasting. Using 105KH paint, 300 pieces of castings were produced after falling sand. The flow channels were inspected after shot blasting. No defects such as sand sticking, sintering, or coating peeling were found (Figure 3). Use a roughness meter was used to measure the surface roughness of the flow channel, and the measured roughness Ra≤6.5. The result meets the

customer's requirements. Afterwards, 3,000 pieces were produced in batches, all of which were qualified.

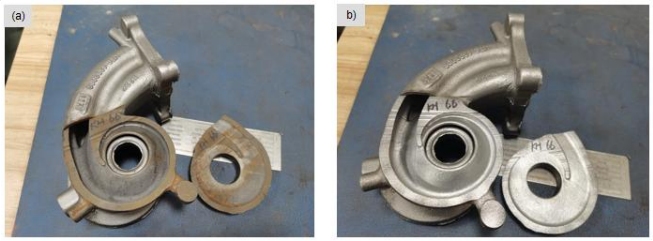

Fig. 3 Samples with water-based 105 KH coatings

3 Conclusion

(1) The black spot defects appearing in the internal flow channel of the heat-resistant steel turbine shell are mainly oxides of Al and Si, and it can be concluded that they are related to the coating.

(2) The weight proportion of Al and Si elements in the slag inclusion defects that appear in the internal flow channels of the heat-resistant steel turbine shell is very small, and they are mainly oxides of Fe, Ni, and Cr. This indicates that the defects come from the oxidation of the matrix, which is related to the oxidation of the matrix. Paint and molding sand have nothing to do with it.

(3) The use of water-based 105 KH zirconium-based paint can effectively solve the coating peeling defects in the internal flow channel of the heat-resistant steel turbine shell. The surface roughness can reach Ra≤6.5, which meets the casting design requirements.

(4) The use of water-based 857 thermal insulation coating can effectively solve defects such as black spots, pores, and cold insulation in the internal flow channels of heat-resistant steel turbine shells, and has a good effect on improving product quality.

References

[1] Xu Jialong. Research on austenitic heat-resistant steel volute casting process [J]. Equipment Machinery, 2014:20.

[2] Chen Shibin, Zhang Shiwei. Application of Italian corefon coating in China [C]. Proceedings of 2019 China Foundry Activity Week, 2019: 11-12.

[3] Zhang Yongfu, Zhao Xinwu. Application of Z889CH coating on heat-resistant cast steel turbine shell [C]. Proceedings of 2020 China Casting Activity Week, 2020: