Exploration of the Transformation of Traditional Large Steel Casting Green and IntelligentManufacturing

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Abstract: Based on the industrial application of intelligent casting for small and medium-sized castings, this article explores and demonstrates the green and intelligent casting technology and equipment for large steel casting from the process of modular core separation, sand core 3D printing and mould-less processing, sand core cleaning, etc., targeting the main product types of large steel castings of CFHI. It provides reference for the transformation and upgrading, high-quality, and sustainable development of large steel casting manufacturing enterprises.

Keywords: large steel casting; green manufacturing; transformation and upgrading

This article combines the industrial application of intelligent casting with sand mold 3D printing as the core for small and medium-sized castings. Based on the main product types of large steel castings of CFHI, the green and intelligent casting technology and equipment for large steel casting are explored and demonstrated from the process of modular core separation, sand core 3D printing, mould-less processing, and sand core cleaning. The aim is to find a technological path for the mechanization, intelligence, high quality, low cost, and sustainable development of large steel casting production, and provide reference for the high-quality development of large steel casting manufacturing enterprises.

1 Overview of the production of large steel casting of CFHI

Our company's large steel casting production mode is single piece and small batch production, resin sand molding, manual operation, with large casting sizes (up to ten meters) and weights (several tons to several hundred tons). The product types mainly include housing, chock, crossbeam (Figure 1), cylinder bodies (Figure 2), upper crowns, lower rings, blades, marine castings, etc. Some products have complex structures and diverse product types, with significant differences in product size, weight, and structure.

Figure 1 Crossbeam

Figure 2 Cylinder body

2 Long term difficulties in the production oflarge steel castings

(1) Poor production environment conditions

(2) Prominent human resources issues

(3)The stability of product manufacturing quality is not high

(4) Long production cycle, low efficiency, high cost

3Overview of Industrial Application of Intelligent Casting for Small and Medium sized Castings

In the field of medium-sized and complex structural cast steel parts (with a net weight of about 5-20t), some enterprises have attempted the "3D+traditional" casting process (see Figure 3). The complex structure of castings adopts 3D printed sand cores during the molding process. The sand box can be transported by heavy-duty AGV (see Figure 4), which can separate the molding, pouring, and shake-out areas, optimize the production environment, and improve the utilization of workspace.


Figure 3 "3D+traditional" casting process

Figure 4 Sandbox AGV transport

4 Exploration and demonstration of green and intelligent casting technology and equipment for large steel castings in our company
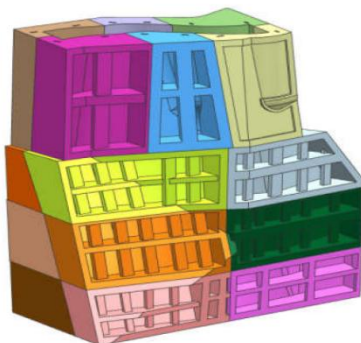
Based on the industrial application of intelligent casting for small and medium-sized castings, we have explored and demonstrated the green and intelligent casting technology and equipment for large steel castings in our company's main product types, including modular core separation, 3D printing and mold free processing of sand cores, sand core cleaning, sand core transportation, sand core storage and assembly, and sand recycling. Specifically, as follows:

(1) sand core modularization

In order to meet the needs of automated transportation and assembly, the direction of intelligent casting is now modular core molding. We select various typical cast steel parts of the company (such as housing, chock, crossbeam, cylinder bodies, blades, lower rings, etc.) one by one for modular core division (see Figure 5 and Figure 6 for the modular core division of blade), and then demonstrate the specifications and quantities of sand core 3D printing or mold free processing equipment.
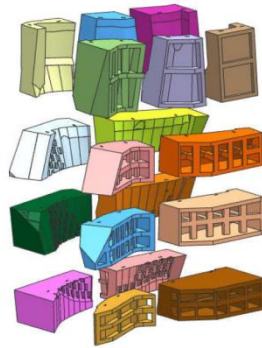
Figure5 Modular blade core division

(2) Core making

The maximum size of sand core 3D printing can currently reach $4 \times 2.5 \times 1.5$m, which can realize the 3D printing of large-sized and complex structured sand cores.

(3) Sand core cleaning

After 3D printing or processing, the surface of the sand core has a layer of floating sand that needs to be cleaned before it can be used. At present, sand core cleaning is carried out by combining mechanical cleaning with manual cleaning.

(4) Hanging and transportation of sand cores

At present, the maximum load capacity of the truss robot is 5 tons. After modular core separation of our typical products, most sand cores weigh less than 5 tons and can be transported using the truss robot.

(5) Sand core storage and assembly

A、 Sand core storage

B、 Sand core assembly

(6) Sand recycling

At present, there have been cases of 3D printing of mechanically regenerated chromite and silica sand. For thick parts of cast steel, a combination of large silica sand cores and small chromite sand cores can be used to reduce production costs and meet production requirements.

5 Concluding remarks

(1) Weight is not the decisive factor in whether large cast steel parts can achieve intelligent casting, the limitation of size and structure is the most fundamental influencing factor;

(2) For types of castings such as cylinder blocks and crossbeams, the "3D+traditional" approach may be a more effective and feasible route;

(3) The housing, chock, upper crowns, lower rings, blades, marine castings, etc. can basically achieve intelligent green manufacturing throughout the entire process.

Figure6 After blade core assembly