Carbon Emission Measurement for Sand Casting Enterprises

Zhong Chen[1], Tianyou Li[1], Wenhao Zhou[1], Mingjun Hou[1], Xiaoyuan Ji[1],*, Yajun Yin[1],Jiankang Lu[2], Jian-xin Zhou[1],*

1. State Key Laboratory of Materials Processing and Die & Mould Technology, Huazhong University of Science and Technology, Wuhan, Hubei, 430074

2. Jiangsu Huaxing Steel Casting Co., Ltd, Taizhou, Jiangsu, 225453

*Corresponding address:e-mail:jixiaoyuan@hust.edu.cn (Xiaoyuan Ji); zhoujianxin@hust.edu.cn (Jianxin Zhou)

Abstract: Sand casting enterprises have long process flow, complex energy structure of melting, pouring and other processes, and many sources of carbon emissions, which makes it difficult to measure the carbon emissions of enterprises. For this reason, this paper carries out a study on carbon emission measurement in sand casting enterprises. Firstly, according to the type of enterprise material, the sand casting enterprise carbon emissions are divided into raw material emissions, fuel emissions and energy emissions; secondly, based on the enterprise process and energy structure, to determine the boundary of the carbon emissions, and the process and carbon emissions corresponding to the type of emission; finally, based on the enterprise data and boundaries, to determine the carbon emissions measurement method and build the carbon emissions measurement model.The research done in this paper provides support for the carbon emission measurement of sand casting enterprises, which is of great significance for sand casting enterprises to realize the goal of "double carbon".

Key words: sand casting; carbon emissions; measurement model

1 Introduction

China became the world's top CO_2 emitter after 2006[1], With the introduction of the goals of "carbon peak" and "carbon neutrality", all fields and industries in China are seeking to green, reduce carbon emissions and gradually carry out low-carbon development planning.China's industrial sector carries about 70% of the country's carbon emissions, andChina's industrial GHG emissions in 2014 were 216% of the 1996 emissions[2]. The foundry industry, as a key pillar of the industrial sector, drives economic growth and meets social needs, while inevitably generating a large amount of carbon emissions[3]. Therefore, it is of great significance to carry out research on energy saving and emission reduction in the foundry industry to reduce the emission of industrial production in China.For this reason, this paper carries out carbon emission measurement modeling research on the main process links of sand casting to provide a basis for carbon emission reduction in sand casting.

2 Analysis of carbon emission types

The use of substances and energy will bring carbon emissions, in the casting of the whole process, the substances used by the enterprise including casting raw materials, sand raw materials, coal, etc., the use of energy is mainly electric energy, research sand casting enterprises, to determine the types of carbon emissions as shown in the Table 1.

Table 1. Types of carbon emissions from sand casting companies

Types of carbon emissions	Instructions
Raw material emissions	Raw materials containing carbon are subjected to a series of reactions that produce CO_2, including carbon emissions from alloying materials, resin sands, paints, etc. produced during the casting production process, and raw materials that can be recycled should be subtracted from the calculation.
Fuel emissions	CO_2 from fuel combustion, including carbon emissions from solid fuels, gas, natural gas, propane, etc., in the production of castings
Energy emissions	Carbon emissions from energy occur at the production stage, and CO_2 is not generated at the time of use, including carbon emissions from the casting production process such as electricity, which are discounted by the amount of purchased electricity.

3 Analysis of carbon emission boundary

The sand casting production boundary is divided into the pouring stage and the post-processing stage, the pouring stage corresponds to the specific molding process of the casting, and the post-processing stage is the casting after the formation of the casting grinding, shrinkage and other treatments, and to determine the input and output of energy and material in each link, as shown in Figure 1.The sand casting production boundary, from the transportation of raw materials to the foundry to the final inspection of the

casting and its successful warehousing, does not include the carbon emissions caused by the mining of raw materials, nor does it include the carbon emissions generated after the casting is sold.At the same time, only the carbon emissions brought about by the casting itself are considered, and the carbon emissions not related to the casting itself, such as enterprise personnel and paper consumption during the production process, are not taken into account, so the enterprise's electricity consumption should be separated from the electricity used for living and casting.If the enterprise is capable of solar power generation, the corresponding generation is discounted and subtracted from the local grid.

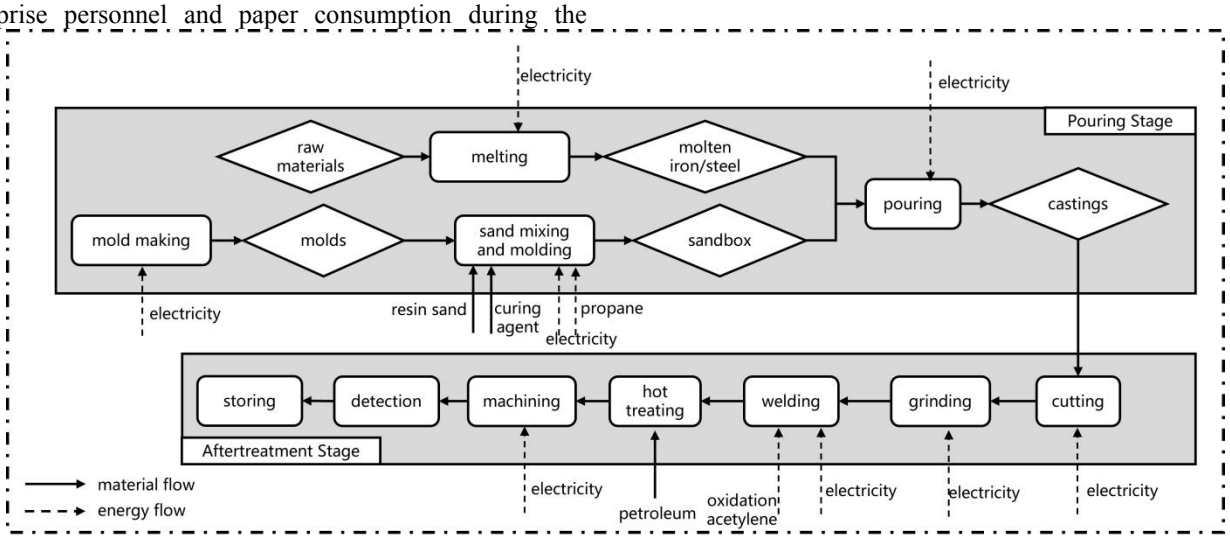

Figure 1 Sand casting system boundary

4 Carbon emission modeling

Modeling of carbon emissions of each type of foundry enterprises.The calculation formula of raw material emissions is as follows:

$$E_M = \sum_i m_i * EF_i$$

Where: E_M-emission of raw materials, $kgCO_2$; m_i-the ith carbon-containing raw material usage, kg; EF_i -the ith carbon-containing raw material CO_2 emission factor, $kgCO_2/kg$.

The calculation formula of fuel emissions is as follows:

$$E_F = \sum_j f_j * Q_j * CCI_j * OFI_j * 44/12$$

Where: E_F-fuel emissions, $kgCO_2$; f_j-jth fuel use, kg; Q_j-jth fuel calorific value, MJ/kg; CCI_j -jth fuel unit calorific value carbon content, kgC/MJ; OFI_j -jth fuel oxidation rate, %.

The calculation formula of energy emissions is as follows:

$$E_E = \sum_k e_k * EF_k = \sum_k \int_0^t P_k dt * EF_E$$

Where: E_E -energy emission,$kgCO_2$; e_k -electricity consumption of the kth equipment, kWh; EF_k -electricity carbon emission efficient, $kgCO_2/kWh$; P_k- real-time power of the kth device, kW; t - time of use of the kth equipment.

Combined with the foundry ERP management software, the input and output of each process is combined with some of the production parameters, such as how much alloy material is used in the raw material and the size of the sand box depends on the three-dimensional parameters of the casting as well as the size of the risers, and the power consumption of the electric furnace during melting depends on the size of the preheating temperature and pouring temperature.Based on the casting process parameters and procedures defined in the ERP process card, the carbon emissions generated per unit quantity of the casting produced can be calculated.

5 Conclusions

(1) This paper classifies and analyzes the carbon emissions of sand casting enterprises into three categories, and determines the specific carbon emission boundaries. Similar processes have similar carbon emission characteristics. By analyzing the process characteristics and energy structure of different types of foundry enterprises, the classification and boundary can be extended to investment casting enterprises, etc.

(2) This paper models different types of carbon emissions. Adjustment of casting process parameters will bring about changes in carbon emissions, but will also affect the quality of castings, how to measure and reduce carbon emissions without affecting the quality of the castings should be taken into account.

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