Cost Accounting and Benefit Evaluation of Carbon Emissions in Cement Enterprises Based on Cluster Analysis

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Abstract: With the rapid development of social economy, the application of cement materials in engineering projects is gradually increasing. Under the concept of environmental protection, the control of carbon emissions in the production process of cement enterprises is conducive to the harmonious development of natural environment and social economy. The cement industry is the basic industry of the national economy, and is also a resource consuming and energy consuming industry. At present, carbon emission reduction has become the main social responsibility of enterprises and an important way for enterprises to achieve sustainable development. The cement industry is a high emission source of carbon dioxide. Therefore, it is of great significance to study the cost accounting and analysis of carbon emissions in the cement industry. As a major contributor to carbon dioxide emissions, China has clearly proposed to reduce carbon dioxide emissions and develop a low-carbon economy. As the main emission source of carbon dioxide, cement enterprises need to provide information on carbon dioxide emission cost through accounting under the background of external carbon emission reduction pressure and internal low-carbon production requirements. As the main body of carbon based energy use and greenhouse gas emissions, the carbon emissions of enterprises are increasingly restricted by laws and regulations, which will put forward new requirements for the traditional cost accounting and management of enterprises. This paper is committed to building a complete system of carbon emission cost accounting of cement enterprises, so as to provide decision-making basis for the strategic development of enterprises, provide data for investors and relevant government departments, and establish a theoretical framework for carbon emission cost accounting and management of enterprises.

Keywords: Cluster analysis, Carbon emissions of cement enterprises, Cost accounting

1 Introduction

Climate change, especially global warming in the past century, is a serious challenge facing mankind, and is also a major global common problem of common concern to the international community today [1]. With the continuous growth of the national economy, China's total carbon emissions have also increased rapidly [2]. As a big country in the world, China should bear some of the different responsibilities and make efforts and improvements [3]. Enterprises shall provide accounting information of carbon emission costs that can be used for carbon emission management [4]. The cement industry is the basic industry of the national economy, and is also a resource consuming and energy consuming industry [5]. On this basis, further

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studies try to put forward a unified carbon footprint accounting step at the material flow level, and put forward the environmental cost collection method, comprehensive life cycle method and activity-based cost method at the value flow level to monetize the carbon emission cost of enterprises [6]. The research on carbon emission cost accounting and analysis of the cement industry is not only of great significance to the cost accounting and management of the cement enterprises themselves, but also an urgent and important research with practical and theoretical significance to establish a low-carbon society [7].

The cement industry is the basic industry of the national economy, and is also a resource consuming and energy consuming industry [8]. The five main carbon emission sources of carbon dioxide in China are solid fuel, liquid fuel, gas fuel, cement production and waste gas combustion [9]. The research on the cost accounting method of carbon emission in the cement industry is not only of great significance to the cost accounting and management of the cement enterprises themselves, but also an urgent and important research with practical and theoretical significance to establish a low-carbon society [10]. The global greenhouse effect caused by the excessive emission of carbon dioxide has attracted great attention of the international community and taken countermeasures. Reducing carbon dioxide emissions has become an important way for enterprises to develop low-carbon economy, fulfill corporate social responsibility and achieve sustainable development [11]. Cement industry is a high emission source of carbon dioxide. Therefore, the research on carbon emission cost accounting and analysis of cement industry is of great significance [12].

2 Enterprise carbon emission cost accounting

2.1 Material flow cost accounting

The need of material flow analysis of carbon cost accounting makes material flow cost accounting one of the basic theories of carbon cost accounting. Material flow accounting is the basis of value flow accounting. It regards the material flow of an enterprise as the center of cost analysis. According to the principle of material input and output balance, an enterprise is divided into several volume centers. According to the sequential movement of the material flow between different volume centers, the flow direction of materials and energy is calculated, and the quantity and cost of positive products and negative products at the output end of each volume center are calculated separately. At the output end, the resource flow cost accounting refers to the produced qualified products as positive products, and its cost is called the cost of positive products or the cost of effective utilization of resources; The waste generated is called negative product, and its cost is called negative product cost or resource loss cost. This accounting method, which divides all materials in the production process of an enterprise into positive products and negative products, and allocates the cost between positive products and negative products, can reflect the proportion of wastes and qualified products in each production link, so as to find out the material center with excessive proportion of negative products, and then analyze the cost composition of negative products, find the source of negative products, and take it as the key object to tap the potential. Fig. 1 is a flow chart of traditional materials in manufacturing industry:

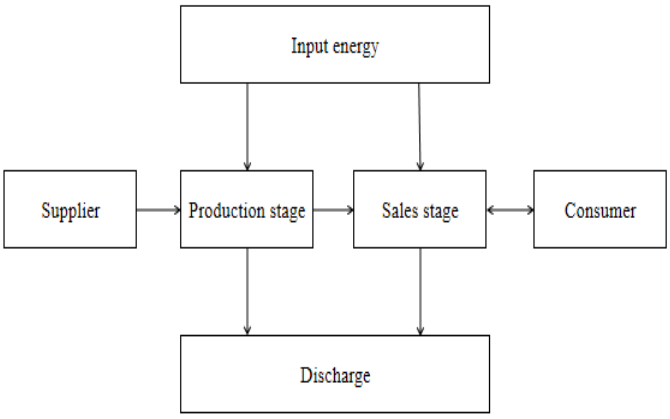

Figure 1 Flow chart of traditional materials in manufacturing industry

The establishment of carbon accounting system needs to reflect and control the carbon activities of enterprises through the accounting of carbon material flow and value flow. The material flow cost accounting provides the accounting method of the physical quantity and value of the material flow, and provides ideas for the accounting of the carbon emission cost of enterprises. Data is the basis of standard and rule customization in the carbon trading market. It includes not only personal carbon, but also the total carbon in the trading market, that is, the total carbon emissions of all enterprises in the market. In the trading market, supply and demand are important reference factors for pricing. The carbon market needs carbon verification to capture the supply and demand of carbon. In cement production, the main emission sources include: first, the combustion of mineral fuels: the emission of physical coal used as fuel for cement kilns, heat treatment equipment and transportation equipment. The second is the combustion of non biomass carbon in alternative fuels and co treated wastes. Third, decomposition of raw material carbonate: in the process of cement production, the decomposition of raw material carbonate minerals generates carbon dioxide emissions, including the decomposition of carbonate minerals, the dust decomposition at the kiln tail and the bypass gas generated by the partial decomposition of carbonate minerals. During the high-temperature roasting of raw materials, most of the non fuel carbon is converted into carbon dioxide. Online generation can be used to offset some of the power purchased from the grid.

2.2 Basic theory of carbon emission cost accounting

Carbon emission cost refers to the consumption caused by the material flow of carbon in each link of the product life cycle, such as the carbon emission and compensation generated by the enterprise in production, manufacturing, logistics, use, waste and recycling. The need of material flow analysis of carbon cost accounting makes material flow cost accounting one of the basic theories of carbon cost accounting. Material flow cost accounting is based on the input, consumption and transformation of materials and energy in the manufacturing process of the enterprise, tracking the change of the physical quantity of the resource flow, and accounting the material quantity and value information of the whole process of the material. It reflects the form and degree of material flow in the production and operation process of the

enterprise and the amount of waste materials from the material and value levels, so that the management can take corresponding improvement measures according to the causes. Its purpose is to improve the quality of material use information, identify inefficient production processes, improve resource utilization, reduce the consumption of materials and energy in the production system, and reduce the threat of pollutant emissions to the environment while reducing costs. The calculation of actual carbon dioxide emissions is as follows (1), (2), (3):

$$C + O_2 \rightarrow CO_2 \tag{1}$$

$$CaCO_3 \rightarrow CaO + CO_2 \tag{2}$$

$$MgCO_3 \rightarrow MgO + CO_2 \tag{3}$$

The product cost of an enterprise can be divided into various element expenses according to the nature of expenses; According to the collection procedures and methods, it can be divided into direct costs and indirect costs. Direct cost refers to the direct labor cost and direct raw material cost consumed for the production of the product; Indirect costs are mainly manufacturing costs. In terms of connotation, the cost of carbon emissions is mainly the cost caused by carbon emissions in all aspects of production activities. As far as the collection procedure is concerned, it also consists of two parts. First, the carbon emission cost that can be directly attributed to a product can be divided into: the carbon emission cost of purchasing raw materials, the carbon emission cost of producing products, and the carbon emission cost of selling or using the products according to the life cycle of the product. Carbon emission material flow analysis is the basis for providing relevant carbon emission information and accounting carbon emission costs.

3 Low-carbon cost management mode of enterprises

3.1 Cement production process

The main raw materials for the production of Portland cement refer to limestone, clay, iron ore powder, marl, chalk and shell with calcium carbonate as the main component. Limestone is the main raw material for cement production. The cement production process mainly includes "two grinding and one burning", i.e. raw material preparation, clinker calcination and cement grinding. Raw material mining: limestone is the main raw material for cement production. In order to reduce transportation costs, most cement projects are located near limestone quarries. The mining and extraction of limestone and other raw materials are usually carried out by blasting or using cutting and loading machines. Crushing: limestone and other raw materials are mined with large particle size and high hardness, so material crushing is required. Generally, after the raw materials are extracted, they are sent to the crusher for crushing or hammering. Crushing is the prelude to grinding and refining, with simple operation and low cost. Grinding. The crushed limestone and other raw materials are sent to the raw material grinding workshop, and the raw materials are ground finer through vertical grinding or ball milling to ensure high-quality mixing. As shown in Fig. 2, the production process of cement enterprise:

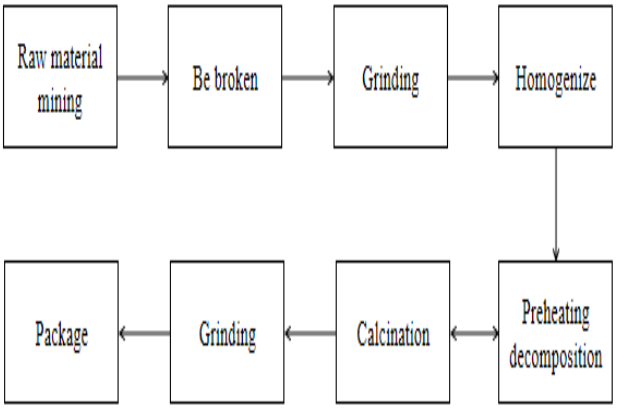

Figure 2 Production process of cement enterprise

Under the action of centrifugal force, it is thrown to the edge of the grinding plate and is rolled and grinded by the grinding roller. The crushed materials overflow from the edge of the grinding plate and are dried by the hot air flow from the nozzle at high speed. According to the different air flow speed, some materials are brought to the high-efficiency powder separator by the air flow. The coarse powder is separated and returned to the grinding plate for re grinding; The fine powder flows out of the mill with the gas and is collected in the dust collection device of the system, which is the product. Figure 3 shows the production data of cement enterprises:

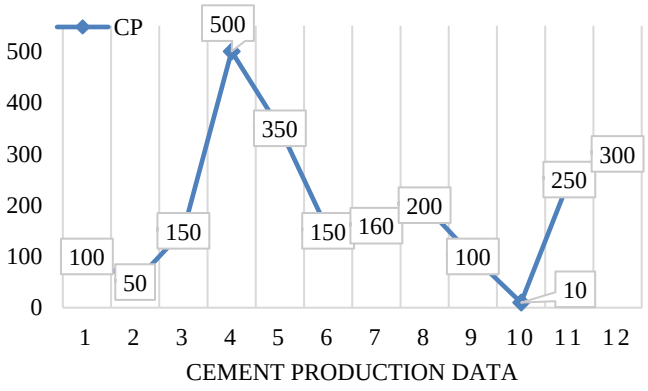

Figure 3 Production data of cement enterprise

Homogenization. In the process of new dry process cement production, stabilizing the ingredients of raw materials entering the cellar is the premise of stabilizing the thermal system of clinker burning. The raw material homogenization system plays the last role in stabilizing the ingredients of raw materials entering the cellar. Preheat decomposition. After the raw meal

is homogenized, it is sent to the preheater through the metering of feed proportion. The main function of the preheater is to make full use of the waste heat from the rotary kiln and the decomposing furnace to heat the raw meal, so as to preheat the raw meal and decompose part of the carbonate. After calcination and cooling, the homogenized raw material is preheated and pre decomposed in the cyclone preheater, and then enters the rotary kiln for calcination. Grinding, cement grinding is the last process of cement manufacturing and the most power consuming process, which meets the requirements of setting and hardening of cement paste. Finished cement is usually stored in huge concrete silos. There are usually two packaging methods for cement delivery: bagging and bulk. Generally, they are packaged by packaging machines and sent for sale by standard trucks or other means of transport.

3.2 Cost-benefit analysis

The purpose of cost-benefit analysis is generally considered to enable the enterprise management authorities to compare the total cost and the total income when making investment decisions on a project or a product, so as to seek to obtain the maximum income with the minimum cost in the investment decisions. However, operations that are considered to be unproductive may also include the extra costs paid by enterprises to reduce carbon emissions in the production process, or the replacement of cheaper non renewable materials with more expensive renewable materials. Although it is beneficial for the enterprise to take such actions from the perspective of environment and society, the purchasers in the market are not willing to pay the increased cost of the operation, and the enterprise may give up the execution of the operation. From the perspective of low-carbon management, the implementation of this operation can effectively reduce the carbon footprint of the enterprise and achieve the goal of enterprise emission reduction. Since the low-carbon cost management of enterprises is different from the general operation and management activities, the low-carbon cost-benefit analysis not only needs to carry out the traditional economic accounting for the investment projects, but also needs to consider the impact of the enterprise's production and operation on the environment from the enterprise level and the product life cycle level, taking into account the economic benefits and environmental benefits. Figure 4 shows the carbon emission cost-benefit data chart:

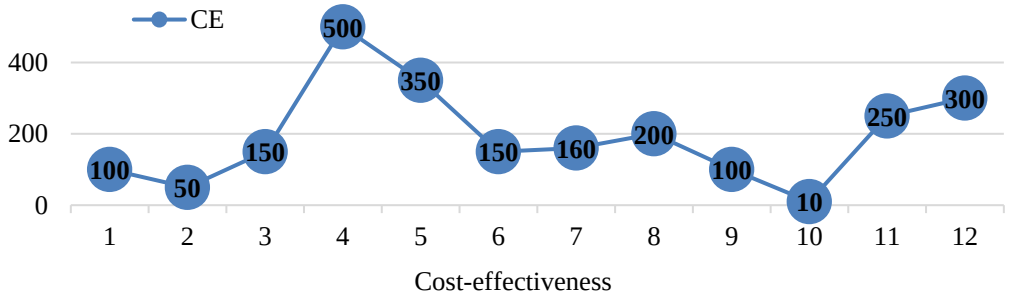

Figure 4 Carbon emission cost benefit data chart

The low-carbon management of modern enterprises should be different from the traditional environmental cost management, and adopt the management mode based on the whole process of the product life cycle, that is, from the design and development stage of the product to the

final waste recovery and treatment stage, the cost-benefit analysis should be adopted to make decisions so as to control the carbon emission cost in advance and finally achieve the goal of reducing carbon emissions. At the stage of product research and development, the design ideas of carbon based energy consumption reduction, low-carbon materials and packaging, and waste recycling should be followed to realize the comprehensive utilization and saving of resources and lay a foundation for the reduction of carbon emission costs in other links; Give priority to purchasing low-carbon and environmental friendly raw materials in the raw material procurement stage, promote clean production in the production and processing stage, increase investment in emission reduction equipment, strengthen resource recycling, energy conservation and emission reduction; Thirdly, the low-carbon logistics approach shall be adopted in the circulation stage of the products. At the same time, through comparison with similar products in the same industry, the carbon emission cost shall be considered in the product pricing, the promotion of marketing and other aspects shall be strengthened, and the wastes in the use and consumption stage shall be easily degraded; The carbon emission costs incurred in the product recovery and treatment stage will be greatly reduced by adopting the above-mentioned low-carbon cost management methods.

4 Conclusions

Based on carbon emission cost accounting, this paper studies the accounting and analysis of carbon emission cost of cement industry. However, compared with the traditional financial accounting, the financial accounting of enterprise carbon emissions has certain similarities. From the perspective of accounting, the basis of carbon emission cost value flow accounting comes from the material flow accounting of carbon emission. In order to make the accounting information provided by carbon emission cost accounting reliable, the physical measurement and monetary measurement of enterprise carbon emissions should be combined. The enterprise shall truthfully and fully disclose the carbon emission cost information so that the external stakeholders can timely understand the impact of the enterprise's business activities on the climate environment and the efforts made to develop a low-carbon economy. Based on the material flow cost accounting, after defining the connotation of carbon emission cost, this paper studies the accounting method of carbon emission cost of cement industry. Through the analysis of the production process and carbon emission characteristics of cement enterprises, the accounting method of carbon emission cost reflecting the production process characteristics of cement enterprises is established, which provides ideas and methods for the accounting of carbon emission cost of cement enterprises, and then provides analysis basis for the management and decision-making of carbon emission reduction of enterprises.

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