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Exploration of information service technology based on enterprise low carbon manufacturing

Yuefeng Zhu

[1]College of Mechanical & Automotive Engineering, Hefei University of Technology, hefei, 230009, (CHINA)

[2]College of Mechanical & Automotive Engineering, Kaifeng University, Kaifeng, 475004, (CHINA)

ABSTRACT

With the continuous development of manufacturing industry, China has made great achievements in the field of mechanical manufacturing, and manufacturing industry has also rapidly appreciated. However, the following questions are continuous, and there are many disadvantages in the development of present manufacturing industry, and the main disadvantage is the social environment caused by of high emissions and high energy consumption. The following will explore the great significance of enterprises low carbon manufacturing on the improvement of environmental problem and the problems encountered in the process of low carbon and the solutions.

KEYWORDS

Low carbon manufacturing; Information technology; Information service.

INTRODUCTION

The information service technology of enterprise low carbon manufacturing is mainly composed of knowledge service technology, evaluation service technology, the life cycle management technology, low carbon manufacturing design technology and information service unit technology and so on. Mutual coordination and interaction, mutual influence exist among all of the information service technology of low carbon manufacturing, and knowledge information service technology has provided intellectual ground for other information service technology, at the same time, other information service technology has played supplementary function on the basic knowledge service technology. For example, knowledge service technology of low carbon manufacturing has provided basic evaluation function for evaluation service technology, and design basis for low carbon design technology, while the evaluation service technology of low carbon manufacturing conduct evaluation and figure out carbon footprint on the product, and the evaluation and carbon footprint together with experience acquired in the design process of low carbon manufacturing flow back to knowledge service technology system, thus the knowledge is able to be recycled and the knowledge base is updated. These information service technologies combine with each other and cannot be separated, and finally integrate with each other on the information service units such as the module design of the products, low carbon management, product optimization, providing effective help for the enterprise implementing low carbon manufacturing and protecting the environment.

The enterprise, through implementing the strategy of low carbon manufacturing plan, can improve the utilization rate of resources, reduce emissions of greenhouse gases and pollutants, lower the consumption degree of manufacturing raw materials, promote the recycling of waste, protect the environment, and provides help to curb global warming.

PARSING LOW CARBON CONTENT AND FRAME STRUCTURE OF MANUFACTURING ENTERPRISE

The concept of low carbon manufacturing

With the rapid development of low carbon economy era, it will lead to profound structural adjustment in manufacturing on a global scale. Low carbon manufacturing is a kind of low consumption, low emissions, low pollution manufacturing mode, through the application of low carbon technology, low carbon management and improvement of low carbon service, it makes every effort to reduce the emissions of GHG(greenhouse gases) happened in the process of manufacturing products such as manufacture, transport, use and processing. Therefore it is a kind of manufacturing way that carrying on economy development and environment protection at the same time. Low carbon manufacturing is different from green manufacturing, and low carbon emphasis is to reduce the emission of greenhouse gases, while green manufacturing refers to improve the environment problems including the factors such as global warming, acidification and so on. So low carbon manufacturing is more targeted than green manufacturing. Low carbon manufacturing is the key way to alleviate global climate deterioration, and is the only way of manufacturing to realize economic and ecological sustainable development.

Frame structure of the low carbon manufacturing

The way of low carbon manufacturing refers to the production cycle of products, so while considering the resource consumption and pollution and carbon emission problem, we should coordinate economic development at the same time, see the basic structure in Figure 1.

Low carbon manufacturing frame structure consists of an achievable goal, a process control and of three main contents.

(1) “An achievable goal” is to control the carbon emission in the process of product manufacturing through the application of low carbon technology and strengthen the management of low carbon, in order to realize the least amount of carbon emissions in the process of manufacturing.

(2) “A process control” refers to control carbon emission in the process of product manufacturing, requiring low carbon manufacturing in the process of design, processing, transportation, sale, scrap and recycling to make full use of limited resources to reduce the emissions of greenhouse gases, and maximum reducing environmental pollution and degradation degree, as shown in Figure 2.

(3) “Three main contents” includes low carbon resource, low carbon production and low carbon products.

The low carbon resource is mainly the application of low carbon raw materials and energy. First of all, the low carbon raw material refers to the raw material that can be regenerated and can be recycled, has high utilization rate and less effect on the environment in the process of acquiring, and easy to breakdown and processed and so on. So in the process of processing the low carbon raw materials, harmful gas emissions shall be avoided. Secondly the low-carbon energy refers to some rich reserves, less consumption, low emissions, less pollution renewable energy, therefore in the processing and manufacturing products, low carbon energy should be chosen possibly.

Low carbon production refers to the enterprises realize low carbonization in the process of manufacturing products, including low carbon production equipment, the manufacture technology of low carbon, low carbon processing environment, etc. Therefore in order to realize low carbon production, we should optimize the manufacturing process, achieve clean manufacture, and choose some production modes which have small pollution to the environment, reduce the processing procedure and improve the energy saving production equipment.

Low carbon products refer to products featuring less resource consumption, less carbon emissions, less energy consumption and can be recycled. Taken together, low carbon manufacturing is a complicated manufacturing process, and it has larger amount of information and data, however, it is difficult to get the data, in this case information services technology is needed to provide technical support. The implementation of low carbon manufacturing mode is affected by the information system frame structure, and information service technology cannot achieve manufacturing of low carbon, but it can provide help for the development of human low carbon. Technology information service platform as the support technology of low

carbon can combine the personnel, choice of energy, and low carbon management in the manufacturing enterprise with low carbon technology together to realize the low carbon manu8facturing effectively.

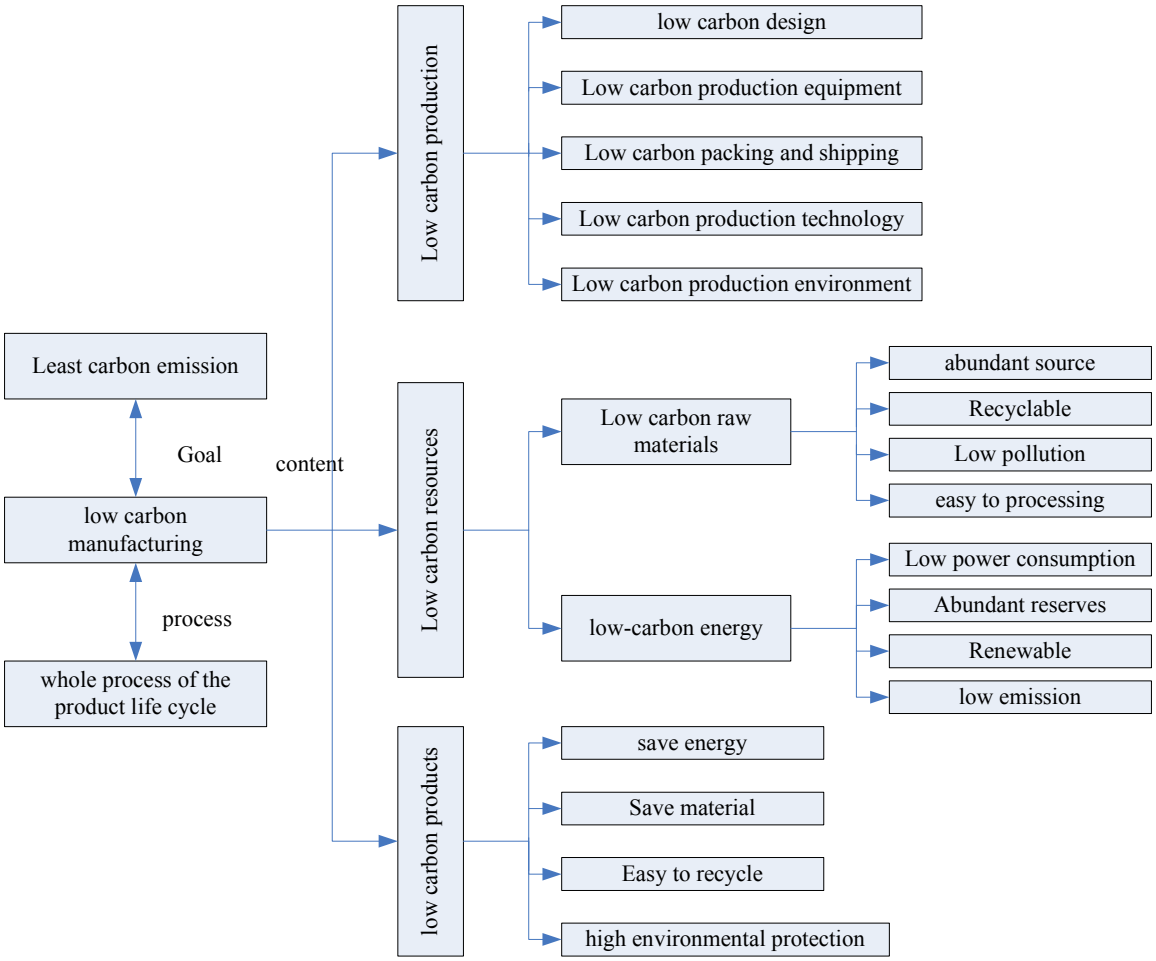

Figure 1 : The basic frame structure of low carbon manufacturing

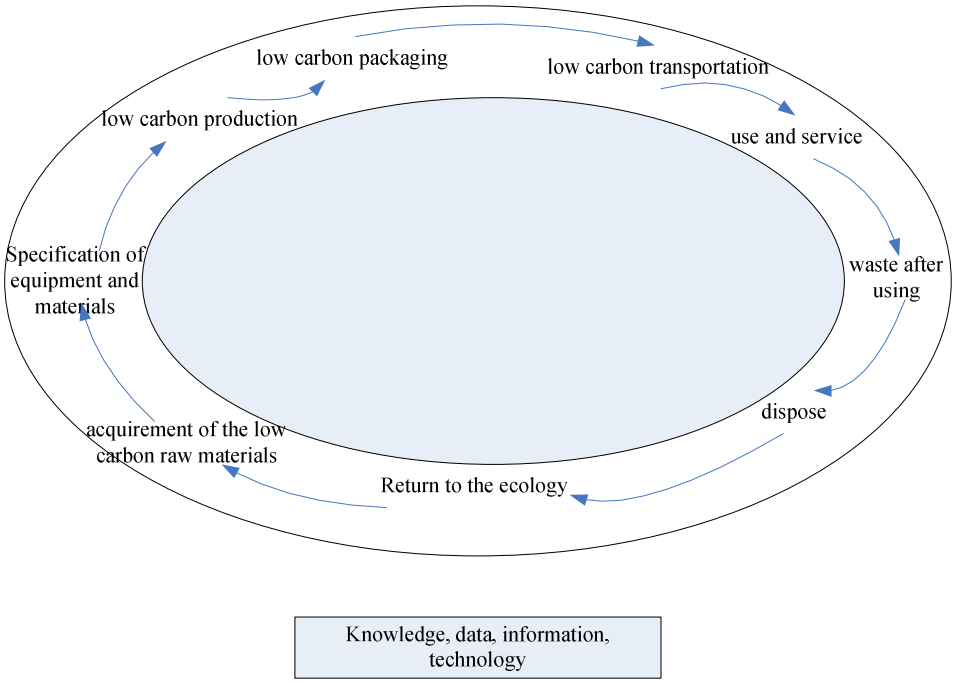

Figure 2 : The control process of low carbon manufacturing

LOW CARBON MANUFACTURING MODEL SETTING AND DATA SPECIFICATION

Technical efficiency refers to the output the ability that can be increased from a given input or input capacity that can be reduced from a given output. The commonly used measurement of technical efficiency is the production frontier analysis method. Production frontier refers to the proportion of various inputs for maximum output under certain technical level. And the production frontier is usually expressed in production function. Frontier analysis method can be divided into the specific parameters method and nonparametric method according to whether known the specific form of production function. The former takes Stochastic Frontier Analysis (short for SFA) as its representative, while the latter takes Data envelopment Analysis (short for DEA) as a representative.

DEA model is mainly used for analysis of technical efficiency. Technical efficiency is usually affected by management efficiency, environmental characteristics and the random error. The first factor is endogenous, and the last two factors are exogenous. So improving technical efficiency needs to distinguish and calculate the specific impact of the three factors on production efficiency. In order to better analyze the technology efficiency of manufacturing under the condition of low carbon economy, the construction of three-stage DEA model is as follows.

The first stage: DEA model

DEA model is divided into two kinds including the input oriented and output oriented. Input oriented is a planning problem which the output level of a certain case, making the input into the minimization. And the output oriented is a planning problem that the input level of a certain case, make the output into maximize. Essentially, the input oriented and output oriented are to solve the same problem from different angles, and the final conclusion is consistent. Because input number is the basic variable of decision-making, and compared with the output, the input is easier to control, therefore, this article adopts variable returns to scale BCC model of the input oriented.

Assuming there are K decision making units (short for DMU), and each decision-making unit use N kinds of inputs and produce M kinds of outputs, therefore the efficiency value of a particular decision making units can be obtained by the following linear programming equations:

$$\underset{\theta,\lambda}{Min}\ \theta^{k}$$

$$s.t.\begin{cases}\sum_{k=1}^{K}\lambda_k x_{n,k} \le \theta^{k} x_{n,k}\ (n = 1,2,\ldots,N)\\ y_{m,k} \le \sum_{k=1}^{K}\lambda_k y_{m,k}\ (m = 1,2,\ldots,M)\\ \lambda_k \ge 0\ (k = 1,2,\ldots,K)\\ \sum_{k=1}^{K}\lambda_k = 1\end{cases}$$

In the above equation, $x_{n,k}$ is the input of section n of the Kth DMU. $y_{m,k}$ is the output of section m of the Kth DMU. λ_k is weighting coefficient of the Nth input and the Mth output. θ^k Stands for the efficiency value of Kth DMU, and the value is between 0 and 1, if the value is closer to 1, showing the efficiency is higher. θ^k Is a relative efficiency, showing efficiency value of the specific individual decision making units, it is a concept that compare with the sample group, $\theta^k = 1$ shows that the efficiency of DMU is the highest of the sample group.

According to the efficiency results of the first stage of DEA, using clustering method, manufacturing industry can be divided into three categories, as shown in TABLE 1.

TABLE 1 : Clustering situation of technical efficiency in manufacturing industry

Category	Manufacturing industry
The first category	Farm and sideline food processing industry, food manufacturing industry, tobacco industries, leather, fur, feather (fine hair) and its products, timber processing, bamboo, cane, palm fiber and straw products
The second category	Chemical fiber manufacturing, ordinary machinery manufacturing, special purpose equipment manufacturing, transportation equipment manufacturing industry, electric equipment and machinery manufacturing, communication device, computers and other electronic equipment manufacturing industry, instrument and culture, office machinery manufacturing
The third category	Others

The second stage: SFA model

Fried and others (2002) argue that the efficiency value has been obtained in the first stage and meanwhile input slack variables of each decision making units has also been obtained, and the slack variables is the difference between the actual

input of the inspected object and the input under the optimum efficiency. They also think that input slack variables are made up of management inefficiency, environmental effect and random error. Building the SFA model can observe the effects of the above three factors on the slack variables respectively.

First we define slack variable：

$$s_{n,k} = x_{n,k} - \sum_{k=1}^{K} \lambda_k x_{n,k} \geq 0; n = 1,2,\ldots,N; k = 1,2,\ldots,K$$

In which, $s_{n,k}$ stands for the nth slack variable of the kth producer in the first stage, and it is the optimal mapping of y_k on the input efficiency subset, y_k is the $x_{n,k}$ input corresponding output vector.

Secondly, establish slack variables and environmental explanatory variable SFA model:

$$s_{n,k} = f^n(z_k;\beta^n) + v_{n,k} + u_{n,k}; n = 1,2,...,N; k = 1,2,...,K$$

In which, $z_k = \left[z_{1,k}, z_{2,k}\ldots, z_{p,k}\right], k = 1,2,...,K$ is p observable environment variables, $f^n(z_k;\beta^n)$ Is the feasible slack frontier, signifying the influence way of environment variable on the input slack variable, it usually takes $f^n(z_k;\beta^n) = z_k\beta^n$. $v_{n,k} + u_{n,k}$ Is the mixed error $v_{n,k}$ is stochastic disturbance, and assuming $v_{n,k} \sim N(0,\sigma^2_{v,n})$; $u_{n,k}$ stands for management inefficiency, and assuming $u_{n,k}$ obeys truncated normal distribution, that is $u_{n,k} \sim N^+(\mu^n,\sigma^2_{u,n})$, $v_{n,k}$ and $u_{n,k}$ are independent and not related with each other. In particularly, making $\gamma = \sigma^2_{u,k} / (\sigma^2_{u,k} + \sigma^2_{v,k})$, and if γ is closer to 1, the influence of management factors dominate, while if γ is closer to zero, the influence of random error dominate.

Finally, adjust the input variables：In order to carry on input adjustment, it is necessary to separate the random error in the mixed error of the SFA regression model from the management inefficiency. Use the regression results of SFA model $(\hat{\beta}^n, \hat{u}^n, \hat{\sigma}^2_{u,k}, \hat{\sigma}^2_{v,k})$ and the conditions of management inefficiency to estimate $\hat{E}\left[u_{n,k} / v_{n,k} + u_{n,k}\right]$, and the estimation of the random error is obtained according to method purposed by Pastor and others (1995) [17] $\hat{E}\left[v_{n,k} / v_{n,k} + u_{n,k}\right] = s_{n,k} - z_k\hat{\beta}^n - \hat{E}\left[u_{n,k} / v_{n,k} + u_{n,k}\right]$.

The following Figure 3 is low carbon manufacturing model.

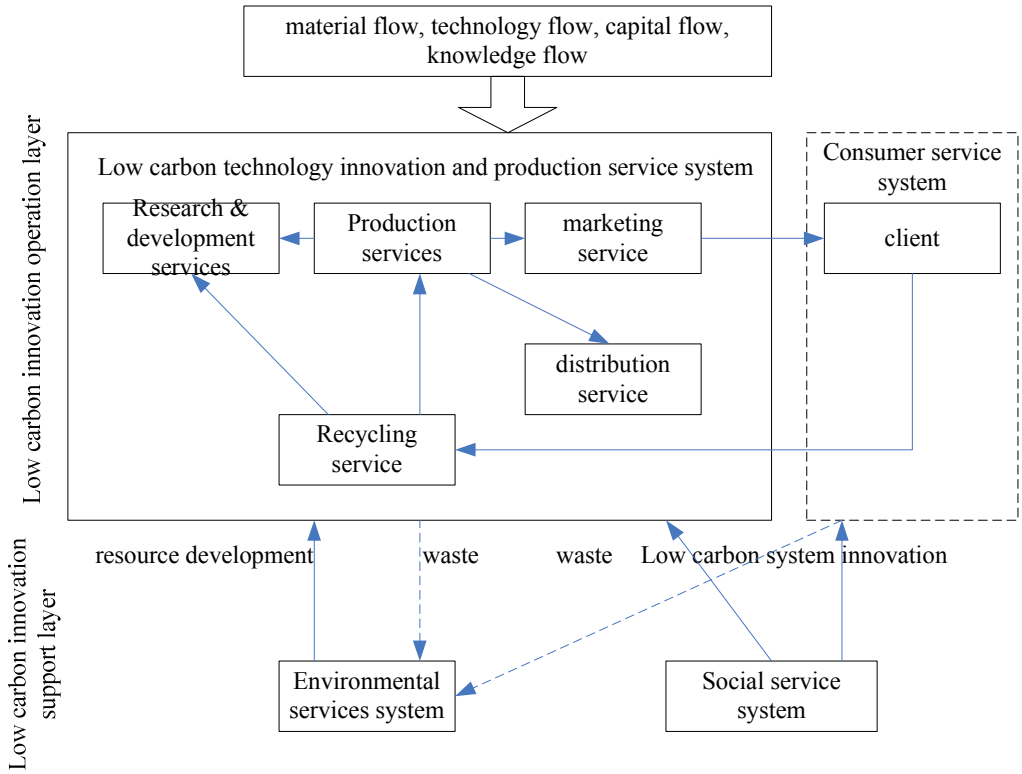

Figure 3 : The productive service industry cluster system model based on low carbon technology innovation

ANALYZE THE PROBLEMS ENCOUNTERED IN THE IMPLEMENTATION OF ENTERPRISE LOW CARBON MANUFACTURING AND THE CORRESPONDING SOLUTION STRATEGY

In the development of China economy, manufacturing industry plays a leading role, since China is the world's first carbon emissions country, therefore, China's manufacturing industry faces the double pressure of international low-carbon tasks and domestic economic development. And China must take the road of low carbon manufacturing, reducing carbon emissions and at the same time keeping the steady development of manufacturing industry. In this case, China's low carbon manufacturing has been put more attention by the people, although many companies have extremely low carbon consciousness, there are still many problems existing in the implementation of low carbon manufacturing. The following will introduce these problems and the corresponding solution strategies in detail.

RAISE QUESTIONS

(1) Enterprises lack the basic knowledge of low carbon manufacturing. Low carbon manufacturing is the latest emerging nouns to reduce carbon emissions, a lot of enterprises don't understand the content of low carbon manufacturing, on one hand, the enterprise don't understand the essence of the low carbon theory, and the basic technology of low carbon manufacturing hasn't been mastered, the calculation method of low carbon footprint hasn't been cleared, so it is difficult to implement the strategy of low carbon manufacturing. On the other hand, the enterprises haven't understood the standard information and patent information of low carbon manufacturing. So they cannot figure out whether low carbon design achieve the standard of low carbon manufacturing, unable to compare low carbon degree of different low carbon design scheme, thus increasing the difficulty of the implementation of low carbon manufacturing.

(2) Lack design concept and design platform in the field of enterprise low carbon manufacturing, resource utilization rate of the product and the degree of environmental impact have great relationship with Low carbon manufacturing design concept. While the enterprise lack the consideration of product impact on environment from the product life cycle in the field of low carbon manufacturing, and also lack priority selection and evaluation ability in the design of low carbon manufacturing.

(3) Lack of some design tools which has guiding function in the low carbon manufacturing, knowledge network is a huge complex structure, and low carbon designer would be easy to lost direction in the process of design low carbon way.

(4) Lack of management system in low carbon manufacturing management system, in the process of implementing low carbon manufacturing, the real data must be provided to calculate and analyze carbon footprint of the manufactured products. And the enterprises must timely collect all the data in the process of manufacturing, including the building materials, manufacturing environment, a load database and the basic material database, etc.

(5) Lack of the evaluation system of low carbon manufacturing, each product has its own different life cycles and the characteristics, for the moment, the evaluation system of low carbon manufacturing product in this industry has been absent between the enterprises, and available reference material that can be referred to in the process of low carbon design and low carbon scheme have also been lacked. Therefore, the enterprises have tried different way of low carbon manufacturing blindly in the process of the design and manufacturing of low carbon manufacturing, wasting a lot of manpower, materials and time.

Taken together, the problems facing in the implementation of low carbon manufacturing of enterprises are mainly low carbon materials, the design of the low carbon, low carbon technology, low carbon equipment and low carbon information, etc. Low carbon manufacturing affects many enterprises where the products complete the entire value, and among them the low carbon manufacturing information service technology has played an important role in the whole manufacturing process. As for the above problems, the following content combines with the design of low carbon manufacturing and information service modernization technology, takes the clothing of the low carbon manufacturing as an example, analyzing the corresponding strategies.

Taking low carbon clothing as an example

Low carbon clothing refers to in the whole process of making clothes from the production of raw materials to fabrics processing, then to design clothing, carbon dioxide emissions has been reduced. Many people couldn't believe that large amounts of carbon dioxide will be produced in the process of manufacturing clothing, starting from planting cotton, linen and other raw materials, through the process of textile fabrics, transportation and sales, as well as the use of clothing and recycling, in which every link large amounts of carbon dioxide or other harmful gases will be discharged, polluting the environment we live. according to some researches, a pair of about 400 grams of pure polyester pants after countless times of washing, ironing and other procedures has consumed a total of about 200 kilowatt-hours electricity in the whole process, starting from the acquirement of raw materials to processing and transportation, eventually to the hands of consumers. And the electricity is provided by coal, after the calculation, about 47 kg carbon dioxide will be emitted, equaling to 117 times the weight of this pants. Clothing materials and manufacturing process will affect the safety of wearing apparel, and adopting green materials and low carbon manufacturing process can reduce the harm to the health of human body and at the same time reduce the pollution to the environment.

Solving strategies

(1) The research work shall be carried out on green product design and evaluation, including the disassembling design of the product, the evaluation index system of the product and manufacturing principles. The basic knowledge

engineering of information services technology, green product manufacturing definition and the evaluation index shall be summarized comprehensively, in order to lay a foundation for the standardization, scientization and rationalization of computer services technology in low carbon manufacturing.

(2) The intensive study of resources circulation mode, integrated operation mode and use evaluation mode and so on in the low carbon manufacturing must establish a preliminary theoretical system and technology system of low carbon manufacturing, and develop the application system of low carbon manufacturing process planning.

(3) Establish a database and select the clean production technology, complete manufacturing fund projects in manufacturing industry, and popularize each enterprise's low carbon manufacturing concept and low carbon manufacturing mode knowledge, providing intellectual support for the implementation of low carbon manufacturing fundamentally.

(4) In the low carbon design, the following measurements can be carried out. 1. Lightweight design: reduce energy consumption and carbon emission in the process of processing and transportation, installation and use of raw materials; 2.Ecological design: under the condition of meet the use function of product, reduce pollution to the environment ecological, give priority to use reusable, renewable, recycled raw materials, strengthen the utilization rate of energy resources, save energy use, and adopt the low pollution, low consumption, non-toxic harmless and no radiation raw materials to reduce the damage to the environment; 3. Modeling design: adopt the modeling series product design to realize the high efficiency of a machine replacing multiple machines, reduce the number of used manufacturing equipment, and use the manufacturing equipment which has the complex function, fundamentally lowering the cost and reducing pollution to realize low carbonization.

CONCLUSION

Under the condition of the earth's resources increasingly exhausted, the usage of energy is highly concerned by the people of the world. Strengthening low carbon manufacturing not only has great significance in the field of machinery manufacture, but also has a profound significance to the world environment protection. We must adhere to the concept of low carbon manufacturing theory and strengthen the low carbon design, low carbon manufacturing management, low carbon manufacturing research and so on, in order to provide help for realizing low carbon manufacturing, and making contributions to the world environment optimization.

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