

## Composite life cycle assessment and Management

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**Abstract:** The whole life cycle assessment method is used to adopt the framework, content and ideas of the economic cost and its environmental impact cost of the composite material from research and development, production to waste recycling, because the composite material is compared with the specific product. The composite life cycle assessment method can objectively and fairly reflect on the advantages of composite materials to the traditional materials, and is also beneficial to realize the social economic and its environmental protection effects of composite materials, and contribution to the enterprise, society, natural environment and sustainable development.

### 1. Introduction

Composite materials have been widely used in the field of national defense and national economy, and have produced great social and economic benefits. In addition to the defense sector, composite applications are used in almost every area of the national economy [1, 2]. According to statistics, in 2011, the output of composite materials in China reached  $3.81 \times 10^6$ t, surpassing the United States to become the world's number one, and carbon fiber consumption can account for 1/4 of the world [3]. Therefore, national and local governments attach great importance to the application and development of composite materials related industries. At present, the depth and breadth of the application of composite materials in China's national economy is still insufficient [4]. Although composite materials have more advantages than traditional materials, the focus of traditional cost evaluation tends to focus on product development costs and production costs, underestimating hidden costs such as product maintenance costs and recycling costs. Under this incomplete evaluation standard, composite materials are considered to have problems such as high development and production costs, environmental impact and recycling difficulties, resulting in limited application. Therefore, it is urgent to evaluate other materials such as composite materials with a more reasonable evaluation system.

### 2. The Proposal of the Whole Life Cycle Evaluation Method of Composite Materials

Life Cycle Assessment (Abbreviated LCA) The method is a method for evaluating the resource and environmental impact of a product from the "cradle to the grave" [5], which is a management method that conforms to the system engineering idea [6]. Compared with the traditional evaluation method, it has objective Advantages such as fairness, practicality, and completeness [4, 7-9]. The use of LCA methods to evaluate and manage the production and application of composite products is of great significance for the development of composite materials industry, the development of national economy and the improvement of social productivity [10]. At present, the domestic composite life-cycle assessment (CLCA) is not enough and data reports are limited.

Composite life cycle cost assessment and environmental impact assessment focus on the economic costs and environmental impacts of composite products throughout their life cycle. From the perspective of composite material research and development, production to recycling and disposal, the overall economic benefits and economic value of the composite materials are investigated, and the environmental coordination, energy conservation, environmental protection and other aspects of the composite materials are evaluated. [11- 14]. According to the evaluation

results, the advantages and necessity of the development of composite materials are further clarified. At the same time, it is also understood that the application of composite materials brings some negative effects, which provides a more comprehensive reference for the development of composite materials and related industries.

### **3. The Meaning of CLCA**

The core of CLCA lies in the fact that the cost of the development and production of composite materials is not sufficient to explain the total cost of products. Decision-makers should not consider the procurement costs, maintenance and maintenance fees, and post-processing fees, but must combine these as the overall life cycle cost of the product is considered as a whole, mainly in the following four aspects.

#### **(1) Early cost control of composite materials**

LCA emphasizes that “product cost is the result of R&D design”. From the perspective of the entire life cycle cost, the cost of early development stage is invested, but the degree of influence is large. The early design determines the main cost, and the later manufacturing, maintenance and recycling costs are very large. It has been determined by early design concepts and frameworks. Therefore, the design of the whole life concept in the early development stage of composite products can minimize the whole life cycle cost of composite materials and increase the efficiency of composite material producers.

#### **(2) Economic design of composite materials**

The economical design of composite materials is also a trade-off between the cost of composite materials. There are many factors that affect the life cycle cost of composite materials. The same parameter design may affect the manufacturing process, reliability, guarantee and maintainability of composite materials, which involves various cost control. The ability to optimize the design parameters and weigh the impact on the cost of each stage can effectively control the whole life cost of the composite material.

#### **(3) To play a composite material inefficient fee-based point**

The establishment of CLCA management concept helps to overcome the traditional cost management of composite materials. It only focuses on reducing the manufacturing cost. The users of composite products only consider the traditional idea of material purchase cost. The CLCA management concept requires not only the production cost but also the use. The cost of the person. CLCA proposes requirements for the quality and function of products and services in response to market demand and resource conditions.

#### **(4) Expanding application areas and guiding development direction**

With the rapid changes in the domestic and international economic and social situation, China's economic development has entered a new normal. For the full life assessment of composite materials, it is possible to discover the cost advantages of composite materials, expand the application field of composite materials, and evaluate the impact of composite material disadvantages on their total life costs. Evaluating how difficult it is to recover composite materials, how difficult it is to degrade the overall life cost of composite materials, and to study the recycling and reuse of composite materials, to continuously develop, eliminate disadvantages, and achieve the development direction of the “green” of the life cycle of composite products.

### **4. The CLCA framework**

The composite material life cycle assessment method implementation framework includes The four basic evaluation processes specified in ISO 14040:2006: definition of objectives and scope; inventory analysis; impact assessment; analysis and elaboration [15].

#### **(1) Defined Goals and Scope**

The purpose of the life-cycle evaluation of composite materials is to analyze the resources, energy consumption, cost and environmental impact of composite products throughout the life cycle, define the cost accounting methods for all phases of composite materials, and identify the

manufacturing economy of composite materials. Measures for benefits and environmental impacts. The full life cycle assessment of composite materials is: cost evaluation and environmental impact assessment during design and development, manufacturing assembly, use and maintenance, and waste recycling.

(2) Inventory Analysis

Inventory analysis refers to the compilation and quantitative analysis of input and output data in the target system. The composite product product life cycle is composed of a series of basic unit processes. These basic unit processes are divided into the following categories: energy, materials, semi-finished products, transportation, use, waste recycling, and each base unit process has a detailed inventory data that contains all the input and output basic elements of the unit process. description.

(3) Impact Assessment

Impact evaluation refers to the use of comprehensive evaluation models for the economic factors and environmental impact assessments of the influencing factors identified in the inventory analysis stage. Impact assessment includes: Impact type, type parameter and characterization model establishment; distribution of life cycle inventory results; inventory data characterization; index results normalization. Composite materials have their own characteristics in the whole life cycle: 1) low energy consumption in the manufacturing process of composite materials, and low emissions of waste gas; 2) accelerated development of composite material recycling technology, improved recycling rate and reduced environmental impact.

(4) Analysis and Elaboration

According to the purpose and scope requirements of the composite life cycle assessment, the results of the whole life evaluation are summarized, and the economic and environmental costs of the composite products in the whole life cycle are systematically evaluated, and the manufacturing cost, maintenance cost and recycling of the composite materials are sought to be reduced. Opportunities and methods such as cost.

5. CLCA Content and Ideas

CLCA mainly includes six aspects of research and development cost, production cost, transportation cost, installation cost, maintenance cost and scrapping cost of composite materials, as well as environmental pollution and negative ecological impact costs in various aspects. The various cost details are shown in Figure 1.

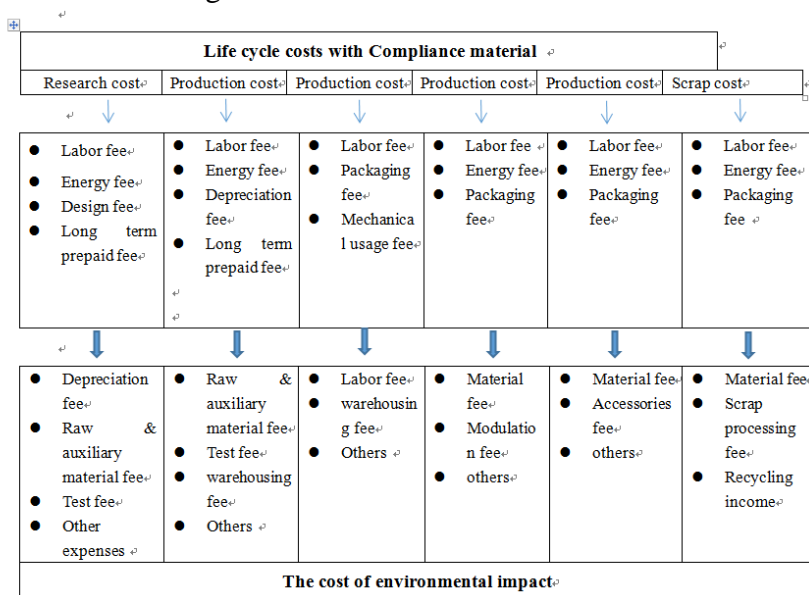


Figure 1 Content of the Composite life cycle

The CLCA composite life cycle assessment method draws on the life cycle assessment methods

of products and materials in other fields, and combines with the production, manufacturing and performance characteristics of composite materials. The basic evaluation ideas are:

(1) The weighting problem between the three decision-making objectives of economic efficiency, environmental impact and energy consumption using the maximum utility standard.

(2) To establish the environmental composite assessment model, an energy consumption assessment model, and an economic evaluation model, then combine the three to obtain a total life cycle cost and its environmental optimization impact based on the utility and weighting method.

## 6. A Brief Analysis of CLCA

Taking the power transmission rod as an example, the non-toxic resin is used in the manufacturing process of the composite electric pole, which has no pollution to the environment, and only weighs 120kg (the weight of the cement electric pole is about 1000kg), although the price is twice that of the cement pole, the manufacturing cost is higher than that of the cement. Electric pole, but it is non-conductive, corrosion-resistant, and has a service life of up to 80 years (cement poles 25 to 40 years). Composite power transmission rods are light, corrosion-resistant and insulated, so transportation costs, installation costs, and post-maintenance costs are much lower than traditional materials. The use of composite poles/towers in coastal areas, mountains and hills has a clear advantage. The island of Hawaii has many weather and climatic characteristics such as high salt, high humidity, high temperature, strong wind, etc. The composite poles installed on the island can still continue to work after more than 40 years of use [16]. The composite electric tower developed by Ebert in the United States has been used for more than 30 years and is still very solid [17]. In 2014, Wimmanson destroyed more than 80,000 concrete and metal poles in Guangdong Province, while the composite poles resisted typhoon attacks and reduced national economic losses [18].

## 7. Conclusion

Research and application of the composite life cycle assessment method that is to maximize the economic, social and environmental protection effects of the composite materials and its contribution to the harmonious and sustainable development of the enterprise, society and the natural environment. Based on the assessment results, it will further clarify the advantages and necessity of composite development, which will also give you an understanding on the application of composite materials, its negative effects and provides a comprehensive and specific direction for the development of composite materials and its related industries.

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