Research on Key Strategies of Green Design and Manufacturing Based on Valve

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Abstract. The paper analyzes the existing problems about low design efficiency and reliability, poor interchangeability and high resource consumption in the design and manufacture of valve industry, designed a set of green planning, green design and manufacturing scheme based on the key technology of green design and manufacturing, such as network and big data platform, provides the maneuverable idea of sustainable development for valve industry.

1. Introduction
Nowadays, the three major problems facing human society are resources, environment and population. With the rapid development of new technologies such as microelectronics and large scale integrated circuits, human society has produced huge demand and consumption of energy and raw materials. The rapid development of industrial economy has brought highly developed material civilization to human beings, at the same time, it has also brought serious environmental pollution problems, and it restricts the sustainable development of human society.

2. The Connotation of Green Design and Green Manufacturing

2.1. Green Design
Traditional design is mainly based on user's function, quality, life and cost. This traditional design method seldom considers the impact of energy, resources and products on the ecological environment. This extensive product design method will cause serious waste of resources and environmental pollution, and affect the sustainable development of human society.
Green design is also called ecological design and environment-oriented design. In the whole life cycle of products, the environmental attributes of products are taken into account, such as disassembly, recyclability, maintainability and reusability. It is regarded as the design objective to ensure the proper functions and service life of products while meeting the requirements of environmental objectives, and guarantee product function, service life, quality and cost requirements[1].

2.2. Green Manufacturing
Green manufacturing is a modern manufacturing mode aiming at resource optimization and environmental protection, also known as environmental awareness manufacturing or environment-oriented manufacturing. Green manufacturing is a kind of generalized manufacturing facing the whole life cycle process of products. It comprehensively considers the damage to the environment and the consumption of resources in the whole life cycle process. It integrates a variety of advanced manufacturing and management technologies. The core content of green manufacturing is green design, clean production and green remanufacturing[2].
3. Architecture of Green Design and Green Manufacturing

Green design and manufacturing technology belongs to the frontier of modern manufacturing technology. It involves a series of advanced manufacturing science issues, such as the transformation of modern manufacturing ideas, sustainable manufacturing theory, the structure of manufacturing system, interdisciplinary and technology integration. Developed countries such as Europe, Japan and the United States are carrying out systematic theory and thematic technology research on green design and manufacturing, which fully reflects the frontier and importance of green design and manufacturing technology. Fig. 1 is one of the framework of green design and manufacturing technology proposed by Chinese scholars.

4. Key Strategies of Green Design and Green Manufacturing

4.1. Green Design Strategy

Green design strategy refers to the use of different design strategies to meet the specific environmental characteristics of design products. The strategies of green design are as follows:

- selection of materials with low environmental impact: this strategy mainly focuses on the choice of materials and the choice of material surface treatment methods, so as to minimize the damage of materials to the environment. For example, as far as possible use non-toxic and harmless materials; as far as possible use recyclable materials, reduce the use of non-renewable materials;
as far as possible avoid the need for high-energy processing materials; as far as possible use recyclable materials and so on.

- designing for disassembly: At present, industrial products require good disassembly, and disassembly design has become one of the focuses of green design research. It requires that the disassembly of product structure should be considered at the beginning of design so that the product structure can be easily disassembled and maintained, and the product can be recycled and reused after the end of its life, so as to save resources, reduce energy consumption and protect the environment.

- design for recyclability: It means to fully consider the possibility of product parts and materials recycling, the value of recycling, recycling methods and recycling process at the initial stage of design, so as to realize the effective utilization of product parts and materials[3].

4.2. Green Manufacturing Strategy
Implementing green technology is an important part of green manufacturing. Green technology refers to the technology that can not only improve economic benefits, but also reduce environmental impact in the process of product processing. Green technology mainly includes resource-saving technology, such as optimum utilization of raw materials, optimum design of blank manufacturing, less and no chips processing and dry cutting processing, energy-saving technology using low energy consumption technology or reducing energy consumption, and environmental-friendly technology considered in the whole life cycle of products.

4.3. Green Packaging Strategy
Packaging is the last link in the production process of products. Green packaging technology is to optimize the packaging scheme of products from the perspective of environmental protection, and reduce the consumption of resources and waste to a minimum. The packaging of products should be reduced; reusable and recyclable packaging materials should be selected as far as possible to reduce resource consumption; non-toxic, pollution-free, recyclable or degradable materials should be selected as far as possible in product packaging; or the demand for packaging materials and packaging costs should be reduced by improving the product structure and increasing the internal structural strength of its products.

5. Application of Green Design and Manufacturing Technology

5.1. Green Planning System for Valve Production Process
The production process of valves is a very complex system engineering. The green planning system of valves is to apply the concept of green design and manufacturing to the production process of valves. The green planning system is not a simple superposition of the existing valve production process, but an optimization and reengineering of the traditional valve production process. Figure 2 is a green planning system designed for the production process of valve products.

The green planning system of valve products is essentially an input and output system based on resource transformation. The operation of green planning system needs the support of planning technology and information technology, resource and environment attributes database, production process attributes database and green manufacturing attributes database[4].
Figure 2. The Green planning system designed for the valve products.

5.2. Green Operation System in Valve Production Process

5.2.1. Green Design Technology of Valve Products
The green design of valves mainly focuses on scheme design, material selection, ergonomics and energy-saving design. The key point of the valve design is the type and configuration of the valve. At the same time, the working condition, control mode, working medium, flow characteristics, connection mode, sealing performance and service life of the valve should be considered. Valve products should consider not only working conditions and performance parameters, but also environmental friendliness, non-toxic, non-polluting, easy to recycle, reusable and degradable materials should be selected. At the same time, the green management of materials should be strengthened.

The good ergonomics design of the valve not only makes the valve easy to operate, adjust and maintain, but also reduces fatigue strength and improves efficiency, effectively reduces safety accidents and protects the environment.

The energy-saving design of the valve embodies in the least energy consumption and energy loss in the use of the valve; the optimization of process design in the production process of the valve to improve production efficiency; the control of pollution sources in production, such as the use and
recovery of cutting fluid in the cutting process of the valve, the ventilation system design in the spraying operation of the valve, and so on[5].

5.2.2 Green Manufacturing Technology of Valve Products

After the green design of valves is completed, the environmental pollution caused by valve manufacturing and assembling should be minimized or eliminated in the process of valve production. With the improvement of CAD/CAE/CAM technology, it plays a decisive role in the green manufacturing of valves, and these advanced manufacturing technologies also greatly reduce the production of manpower, resources and waste. Therefore, the use of these advanced manufacturing technologies can better ensure the smooth completion of green manufacturing of valve products. Dry cutting can not only improve the processing accuracy and surface quality of valve products, but also greatly reduce the cost of cutting tools and production, and reduce the consumption of resources and energy. For example, the cutting speed of dry hobbing machine tool can reach 5 times of that of traditional machine tool, and the production efficiency can be increased by about 4 times. Compared with wet processing, the cost of dry hobbing machine tool can be reduced by 45%, and the quality of parts processed is also higher.

Using less chip-free and numerical control technology to manufacture parts can reduce the consumption of raw materials and save resources, improve production efficiency, optimize cutting parameters, reduce labor intensity and reduce labor costs. Now it has been widely used in the valve industry.

Valve products have many reusable parts and high utilization rate. A large number of parts can be reused through valve re-manufacturing, which can reduce the repeated pollution of foundry, welding, cutting and heat treatment, and the repeated consumption of resources and energy. It also avoids the resource consumption and environmental pollution when the valve parts are recycled. Figure 3 is a diagram of a valve enterprise based on green manufacturing system[6][7].

![Figure 3. The green manufacturing system of valve.](image)

5.3. Green Evaluation Support System for Valve Production Process

How to evaluate the greening of valve production process is also an important technology to be considered in green design and manufacturing of valve industry. At present, the world's recognized product green standards mainly focus on three aspects:

- the product life cycle process, less consumption of resources and energy, less or no pollution to the environment according to specific environmental protection requirements.

- low energy consumption in the use of products, will not cause pollution hazards to users, will not produce new pollutants.
products can be decomposed and disassembled after use, its can be re-manufactured after the end of life. The evaluation methods of green products mainly include cost-benefit method, value analysis method, weighted scoring method, analytic hierarchy process and fuzzy evaluation method[8]. Based on the database of valve manufacturing process, the green evaluation support system of valve products based on expert system is established, and the reasonable green evaluation index is established for the relevant technological links of valve design and manufacturing process. Then the green evaluation of valve production process is carried out according to the knowledge base of expert system.

6. Conclusion
Green design and manufacturing technology, as a new modern manufacturing concept and mode, has been paid more and more attention by manufacturing industry. The research on green design and manufacture of valve products involves multi-objective and interdisciplinary knowledge. It requires close cooperation among government, enterprises, research institutes and related disciplines in order to achieve theoretical and technical breakthroughs and achieve due economic and social effects. Space considerations.

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