Research on green manufacturing technology

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Abstract. The current situation, the contents and the features of green manufacturing technologies are introduced. The related technologies and the key technologies of green manufacturing technologies are analyzed. The contents, the targets and the carry out ways of green manufacturing technologies are researched. The development tendency and the application vistas of green manufacturing technologies are prospected.

1. Introduction
Environmental, resources and population are three main problems facing the world today, the deteriorating environmental problems have posed a serious threat to human survival and development. The waste in the process of transforming resources into products leads to serious environmental pollution. Green manufacturing is a modern manufacturing model considering both environmental impact and resource efficiency under the premise of guarantee the quality, the features and the cost of the product, make the products environmental pollution minimized from the design, manufacture, use to scrap in the whole product life cycle, so that the resource utilization rate is the highest and energy consumption is the lowest[1, 2].

The traditional manufacturing model is an open loop system, which uses the end of treatment method to protect the environment from raw materials, production, use to scrap, the method of terminal treatment to protect the environment. Green manufacturing considers the product environmental attribute and the basic attributes of products, in the product whole life cycle by the viewpoint of system integration to grab from fountainhead, make the products satisfy the requirement of environmental objectives, to ensure its basic performance, quality and life. This paper studies green manufacturing technology.

2. Present situation of green manufacturing technology
With the rapid development of the manufacturing industry, environmental issues have become increasingly prominent and become the attention focus of all countries. The "green wave" makes the manufacturing industry change the traditional manufacturing mode and promote green manufacturing technology.

2.1. Current situation abroad of green manufacturing technology
The "green plans" with environmental protection as the theme has been developed, such as Japan's "Green Industry Plan" and Canada's "Green Plan". More than 20 countries, including the United States, The United Kingdom, Germany, France, Switzerland, Finland, Singapore, Malaysia and Australia, have implemented environmental labeling to promote the development of "green products" in these countries.
2.2 Domestic research basis
At present, an evaluation system with environmental protection green technology as the research carrier, evaluation technology verification (ETV) is introduced into green design and green manufacturing in the machinery manufacturing industry to establish the green concept, description method and ETV evaluation system[3]. The main research content of green manufacturing as follows: the establishment of green product design evaluation system model, clean production technology of green products, detachable and recyclable technology of products; noise control technology of mechanical and electrical products, green manufacturing technology oriented to the environment, energy and materials.

3. The connotation and characteristics of green manufacturing technology

3.1 Connotation of Green manufacturing technology
Green manufacturing is a modern manufacturing mode that comprehensively considers environmental impact and resource efficiency. Its goal is to coordinate and optimize economic benefits and social benefits of enterprises. The connotation of green manufacturing is as follows: (1) Green manufacturing involves three parts: manufacturing, environmental impact and resource optimization. (2) The "manufacturing" in green manufacturing refers to the whole life cycle of a product. It is a "big manufacturing" concept and reflects the characteristics of "big manufacturing, big process and interdisciplinary" of modern manufacturing science. (3) Manufacturing concepts related to green manufacturing are generated around environmental problems in the manufacturing process. (4) Green manufacturing is a modern manufacturing mode that fully considers resources and environment. (5) Green manufacturing is the embodiment of sustainable development strategy of human society in modern manufacturing industry.

3.2 Features of green manufacturing
Green manufacturing has the following characteristics: (1) Systematically. Compared with the traditional manufacturing system, the essential feature of green manufacturing is that green manufacturing not only guarantees the general functions of the manufacturing system, but also guarantees the minimum environmental pollution. (2) Focus on prevention. Green manufacturing emphasizes the prevention of environmental pollution in the production process of products and the elimination or minimization of waste. (3) Keep fit. Green manufacturing must combine the characteristics of products and process requirements, so as to meet the requirements of the expected development, without harming the ecological environment and maintaining the rational use of resources. (4) Economic compliance. The application of green manufacturing technology can save the consumption of raw materials and energy, reduce the cost of waste treatment and disposal, reduce the production cost, improve the economy of products and enhance the market competitiveness. (5) Pay attention to effectiveness. Green manufacturing has shifted from the treatment of the end of products to the continuous control of products and production process, and comprehensively utilized the recycling technology of renewable resources and energy and materials to effectively prevent secondary pollution [5,6].

4. Green manufacturing system
Green manufacturing is a system engineering, it consists of some sub-system as follow: marketing sale green design, green manufacturing, quality assurance, processing recycling, material and energy resources, environmental assessment as well as environmental database and knowledge base support sub-system.

Green manufacturing system mainly studies related concepts, application scope and system framework of green manufacturing mode. Green manufacturing system aimed at to establish basic models and provide general guidance for the implementation and research of green manufacturing technology [4]. Green manufacturing system technology is a content-rich and complicated system, it involves many manufacturing-related technologies. Green manufacturing system can be summarized
as three contents, three approaches and two objectives. The green manufacturing system model shown in figure 1.

4.1. Contents of green manufacturing.
The green manufacturing is a process of the green materials and green energy through green design of green product production. Green energy refers to saving energy and resources as much as possible in the whole process of product life cycle so that it can be fully utilized. Energy conservation requires efficient use of energy, or it is based on safe, reliable and inexhaustible energy sources, such as solar, wind, biomass, geothermal, marine and soon.

Green manufacturing process is refers to the green product design convert to all of the actual product process, it is material transformation process of the products as the main line, at the same time ensure smooth logistics integration and effective management means, including green design, green material, green technology, green production equipment, green packing, green marketing and green management, etc.

The purpose of green manufacturing is to meet specific environmental protection requirements throughout the life cycle, harmless to human body, with no or minimal impact on the environment. The product structure is as simple as possible without reducing functions, the consumption of raw materials as little as possible without affecting the life, and the consumption of energy as little as possible without affecting its efficiency. At the end of their service life, parts of product can be recycled, reused or disposed of safely.

4.2. Three ways of green manufacturing.
There are three ways to achieve green manufacturing: (1) change the ideas, establish a good awareness of environmental protection; (2) take technical measures to solve the problems for specific product environmental problems; (3) strengthen management and improve personnel quality, use the market mechanism and legal means to promote the development of green technology and green products.

4.3. Two goals of green manufacturing.
The goals of green manufacturing are comprehensive utilization of resources and environmental protection. In the process of product design and manufacturing, product design and manufacturing system and manufacturing environment, the two process of green manufacturing for the whole process of the optimal control, the rational allocation of resources, maximize the effectiveness of the manufacturing system, the realization of ultimate resource of energy conservation and environmental protection green manufacturing goals have always been required in accordance with requirements of the three contents of green manufacturing.
5. Related technologies and key technologies of green manufacturing

5.1 Relevant technologies of green manufacturing

5.1.1. Modern design technology.
The key to green manufacturing is green design, so modern design technology will be the main related technology of green manufacturing.

5.1.2. Advanced manufacturing technology and equipment.
Advanced manufacturing technology and equipment are the foundations of equipment and process of green manufacturing system, it is also the foundation of realizing high quality and efficiency and low consumption and clean production, to guarantee product quality and market competition, so it is the important pillar of green manufacturing.

5.1.3. Environmental engineering technology.
The purpose of green manufacturing is to make the most effective use of resources and produce waste at the lowest level to fundamentally reduce the negative impact on the environment. Therefore, environmental engineering technology will be an important supporting technology in the field of green manufacturing.

5.1.4. Environmental technology standards and policies and regulations on resource utilization.
With the development of networked, integrated and intelligent manufacturing, environmental technology standards and resource utilization policies and regulations of green manufacturing have become more and more important. Green manufacturing involves the government's behavior of legislative and administrative provisions, and the government can formulate economic policies and use the mechanism of market economy to guide the implementation of green manufacturing.

5.1.5. Systems engineering technology.
Implementing green manufacturing is a complex system engineering problem. The degree of resource consumption and environmental pollution, the evaluating the status and degree of green manufacturing implementation are use the system engineering method in measuring and evaluating manufacturing system.

5.1.6. Communication network and database support technology.
In order to meet the requirements of green design and manufacturing, the corresponding green design database and knowledge base must be established and managed and maintained on the basis of developing the communication network.

5.1.7. Concurrent engineering technology.
Concurrent engineering is of special significance to green design. Green design requires the same design goals for example reduce resource consumption, easy to disassemble and recycle, protect the ecological environment and ensure the product requirements in performance, quality, life, cost, and ensure the smooth implementation in the production process from the beginning of the product design.

5.2 Key technologies of green manufacturing
The key technology system of green manufacturing includes three aspects: the theoretical system and overall technology of green manufacturing, the special technology of green manufacturing, and the supporting technology of green manufacturing. Among them, the first aspect includes the theoretical system, system structure, multi-life cycle engineering, system operation mode, energy and resource system of green manufacturing. The second aspect includes green design technology, green material selection technology, green process planning technology, green packaging and green processing technology. The third aspect includes database and knowledge base of green manufacturing,
environmental impact assessment system of manufacturing system, green ERP management mode and green supply chain, social support system of green manufacturing, implementation tools and products of green manufacturing.

5.3 Green manufacturing process

Green manufacturing technology is the core of green manufacturing, aimed at rational use of resources and energy to reduce environmental pollution. At present, the green manufacturing process uses the methods as following: (1) no chip processing technology, which can greatly reduce energy consumption and material consumption, such as precision casting, cold extrusion, 3D printing and similar equal materials processing technology; (2) Dry processing technology, compared with traditional cutting fluid processing, this technology has the advantages of less environmental pollution and lower processing cost; (3) Through accurate design and reasonable planning to reduce the machining allowance, can greatly reduce the energy and material consumption of cutting, shorten the processing cycle; (4) Improve the lubrication mode, the traditional oil injection lubrication oil consumption is large, environmental pollution is also large, and due to the high consumption of lubricating oil, resulting in high processing cost, oil and gas lubrication can well overcome the lack of oil injection lubrication, become the future direction of development.

The machining method of minimum quantity lubrication (MQL) has made great changes in the lubrication technology. The MQL lubrication system uses very little oil. The use of MQL has certain advantages: (1) less oil consumption; (2) there is almost no oil on the chip; (3) only a little oil is attached to the workpiece, and the cleaning process of the workpiece is simple; (4) no lubrication management is required; (5) omit the cooling circulation system; (6) MQL device can be easily installed on machine tools. For the problem of poor cooling effect when using MQL lubrication, oil-water composite fog MQL processing method can be used to spray the atomized lubricating oil and water to the cutting point at the same time.

6. Development trends of green manufacturing technology

The research content system of green manufacturing technology is forming and will develop towards the following trend.

6.1 Globalization

The research and application of green manufacturing show features and trends of globalization, which are reflected in: (1) The impact of manufacturing industry on the environment is beyond space. (2) The successive release of ISO14000 series standards related to environmental management system has laid a foundation for the globalization research and application of green manufacturing. (3) With the formation of the global market in recent years, the market competition for green products will be global. (4) The imported products shall be identified as green and affixed with a "green mark".

6.2 Socialization

The research and implementation of green manufacturing requires the joint efforts and participation of the whole society in order to establish the necessary social support system for green manufacturing. To implement green manufacturing effectively, enterprises must consider the treatment after the end of product life, which may lead to the formation of a new integration relationship among enterprises, products and users.

6.3 Integration

The research of system technology and integration technology will be paid more attention. Green manufacturing involves the whole process of product life cycle and all aspects of enterprise production and operation activities, so it is a complex system engineering. In order to implement green manufacturing effectively, the related problems in green manufacturing must be considered and studied from the perspective of system and integration. The integration of functional target system,
product and process design and material selection system, user demand and product use, problem domain integration of green manufacturing, information integration of green manufacturing system and process integration of green manufacturing will become important research contents of green manufacturing.

Another aspect of green manufacturing integration is that the implementation of green manufacturing needs an integrated manufacturing system. Green integrated manufacturing technology and green integrated manufacturing system will become the focus of green manufacturing research in the future.

6.4 Parallelization
Green concurrent engineering is a systematic approach to design products and their whole life cycle in an integrated and parallel manner, striving to enable product developers to consider the quality, cost, schedule, user requirements, environmental impact, resource consumption and other factors in the entire life cycle of products at the beginning of the design. Green concurrent engineering will become an effective mode of green product design and development, and green design will continue to be the key technology in green manufacturing in the future. An important trend of green design in the future is the combination with concurrent engineering, thus forming a new mode of product design and development model.

6.5 Intelligentize
Artificial intelligence and intelligent manufacturing technology will play an important role in green manufacturing research. The decision-making target system of green manufacturing is the existing manufacturing system TQCS (T-product launch time, Q-product quality, C-product cost, S-service for users), add E-the environmental impact and R-resource consumption, thus forming the decision-making target system of TQCSRE. The optimization of these objectives needs to be supported by artificial intelligence. Artificial intelligence technology based on knowledge system, fuzzy system and neural network will play an important role in the research and development of green manufacturing.

6.6 Industrialization
Green manufacturing will lead to the formation of a number of new industries, which, in addition to waste recycling equipment manufacturing and waste recycling services, also include the manufacturing of green products and the implementation of green manufacturing software industry.

7. Conclusion
Environmental protection is an urgent problem to be solved. The healthy development of manufacturing industry must be based on green manufacturing. Therefore, on the basis of fully understanding the connotation and characteristics of green manufacturing technology, efforts are made in key technologies such as green design, green materials, green process and green treatment. A perfect green manufacturing system should be built, and the globalization of green manufacturing through the integration, parallel, intelligence, industrialization and socialization of green manufacturing will be realized.

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