

Green Maintenance Strategy and Recycling Economy

Cheng Huiqiang*, Wu Yufeng
Institute of Recycling Economy, Beijing University of Technology, Beijing 100124, China
e-mail: hqcheng@bjut.edu.cn

Abstract

Green maintenance is a significant technical way to realize the sustainable development of society, which embodies the inherent requirements of recycling economy. In addition to its economic and technical functions, the green maintenance has important social functions, which plays a crucial role in saving energy and reducing emissions, developing recycling economy and building a resource-saving and environment-friendly society. Therefore, some positive measures should be taken and relevant policies be promulgated to promote the vigorous development of green maintenance.

Keywords: Green maintenance; Recycling economy; Saving; Environmental protection; Strategy

1 Introduction

Maintenance is the protection of safety and environment. As an investment in the future, maintenance is able to create new productivity and helpful to save raw materials and energy, protect environment and increase profits in the industrial production. Since the "reliability-centred maintenance" system created in the 1960s, lots of new maintenance systems have developed such as precision maintenance, intelligent maintenance, green maintenance and advanced maintenance. Green maintenance requires the maximum utilization of resources, the least waste and environment negative impact in the life cycle of a product from its design, manufacturing, usage and waste treatment. In addition to its economical and technical functions, green maintenance has an important social function, which is beneficial to develop recycling economy and build a resource-saving and environment-friendly society. With the concept of scientific development and sustainable development implementing, some new opportunities will be offered for green maintenance and it will be enriched by some new contents.

2 Green maintenance reflects the inherent requirement of recycling economy

Green maintenance is an important technological way to realize the sustainable development, which can achieve reductions and has become an important link in the recycling economy. The maintenance generally brings the consumption of resources and energy, produces waste and induces pollution. Therefore, new technologies, new processes and new equipment need to be applied and enterprise management should be strengthened to save resources and energy and decrease pollution. This type of maintenance is regarded as green maintenance. The green maintenance comes into being in implementing the concept of scientific development and sustainable

development and brings the fundamental reform in the traditional concept and technologies in maintenance and a new growth in maintenance industry. Under the new historical conditions, the green maintenance has broad developing prospects, so, the researches on its theories and technologies have become an important prerequisite and urgent task.

Even though the waste pollution generated by a separate maintenance of a product is very little compared to product manufacturing, the consumption of resources and waste pollution throughout its life cycle is very much. For example, the water consumption reaches 70 to 80 liters for a separate car wash in Beijing. The number of cars in Beijing had increased to more than 2.4 million in 2005. If only half of these cars are washed for 50s in one year, the all water consumption can reach 3 million cubic meters, which is almost equal to the whole water storage capacity in the Kunming Lake of Beijing. It is obvious that the consumption of resources is so large for only a simple car wash in Beijing, hence, the green maintenance, like green production and green manufacturing should also be paid attention to.

In the 80-90s of last century, the maintenance had been related to sustainable development of society and environment protection. In the early 1990s, the concept of "green maintenance" was proposed, which required the aim of maintenance to be realized by using advanced technologies and equipment at the cost of the least resources and energy consumption, the least waste and environmental impact.

The environmental awareness should be infiltrated throughout every link of production design and manufacturing. For example, the environmental guidelines are necessary to be founded so as to prevent the adverse effect on the environment from some machine faults. Different technologies and methods including some analysis based on life cycle assessment, reuse, recovery and recycling of equipment maintenance and waste should be applied to eliminate the impossible environmental damages.

The basic theories and technologies of green maintenance are extremely rich, which are composed of the relative basic theories and the extension of some concepts in them when the impacts of maintenance on the environment are

considered, the management and technical regulations on green maintenance, the detecting

technologies and monitoring means on environmental and resource consumption. They are mainly described as follows:

2.1 To consider green maintainability should in product design

Green maintainability should be considered in product design. The negative impacts of maintenance on environment are necessary to be eliminated or weakened by some measures in product design. For example, the maintenance program design should be founded according to the indicators meeting energy-saving, resource-saving and cleaning requirements.

2.2 Green maintenance analysis and evaluation

Whether the product maintenance could reaches the green maintenance requirements, a complete set of analysis, evaluation, weighing technologies are very necessary. Their contents mainly consist in environmental impact analysis on the maintenance and management in addition to the traditional maintenance analysis. The environmental impact of preventive maintenance and reparative maintenance of expected products and analysis of the irreparable faults and the scrapped machines treatments should be considered. The specific contents include the consumption of resources, the recovery and disposal of maintenance waste and the "3R" treatment of scraps. According to environmental impact analysis of maintenance and treatment, the information on the repairable design of parts and components, the choice of materials of maintenance design and the connections of parts and components can be supplied for technical supports on development of maintenance process. The models and methods including time, cost, resources consumption and environment impacts of maintenance should be built.

2.3 Green maintenance operating technologies

The green maintenance operating technologies are used to eliminate or decrease the environmental impacts of equipment maintenance in its using stage, which are usually composed of green maintenance materials, surface technology and engineering, machining process, components-cleaning, heat treatment and so on. In all these technologies, the surface technology and engineering is the key one. Viewing from the present conditions, the improvement or renovation of technologies on green maintenance are water-saving, especially anhydrous cleaning, surface treatment, saving and precision in parts manufacturing and treatment of maintenance waste. The precision control and some advanced technologies in manufacturing, materials and information are the main way to decrease the energy consumption and pollution.

2.4 Green maintenance management

The management is more important to realize green maintenance, compared to technologies. Some measures in the management should be implemented as below: The related policies and regulations are necessary to established, for example, the promotion law on cleaner production. The environment awareness are popularized in the maintenance personnel related to equipment management and design and manufacturing. The green maintenance theory and technology system should be strengthened by using scientific research. The funds for green maintenance should be strengthened more to promote the transformation of maintenance technologies.

3 Green maintenance strategy is realized in the life cycle according to the idea of recycling economy.

3.1 Green maintenance embodies in product design

The product design is the precondition for green maintenance. The factors including materials, structure and life cycle should be considered in green maintenance.

(1) Materials choice: the requirements of environmental protection, energy-saving and materials-saving should be considered in materials choice. The types and amount of materials need to be decrease as possible. Green materials are recommended to used. The reparability and recovery of valuable parts and parts made of rare materials are emphasized

(2) Structure design: the equipment or structure connections should be realized as possible as simple. For example, the removable design is offered to pipelines in process industry and interchangeable or modular design is offered to the equipment in the other industries.

(3) The reliability study is recommended and the maintenance-free design is extended when the all cost of products in life cycle is considered. For example, the maintenance-free design is proposed to be used for the key equipment and the equipment easy to cause great loss due to its stop in process industry and the value equipment in non-process industry

3.2 Green maintenance penetrates in manufacturing process

The remanufacturing engineering should be considered in production manufacturing methods. Taking the remanufacturing of automobile engines for example, the old automobile engines are remanufactured by using special equipment and

technologies according to new standards. Compared to repairing, manufacturing has some advantages to

realize higher quality, higher properties, more interchangeable and rapid replacement and almost equivalent cost. Therefore, the remanufacturing has become an important way to solve the contradictions between the development, environmental protection and resource-saving. Additionally, a value-added can be created by remanufacturing compared to the traditional repairing of old parts and utilizing waste parts of equipment. For example, the remanufacturing is able to realize the recycling of 85% value of old automobile engines while only 3% value can be reused if they are remelted.

3.3 Green maintenance realizes in maintenance process

Before maintenance, the equipment condition monitoring and fault diagnosis are necessary, which can implement state maintenance and enlarge the time interval of overhaul. During maintenance, many new technologies should be applied to improve quality and efficiency and decrease the possible pollution. For example, the environmentally friendly paint dry grinding device is used in automobile maintenance in order to prevent dust pollution containing harmful chemical composition. After maintenance, to do well in the maintenance site environment is very important. The maintenance location and position of maintenance tools components and materials all are necessary to meet a special requirement.

4 Green maintenance is developed to promote the construction of resource-saving and friend-environment society

The "CPC Central Committee on the Formulation of National Economic and Social Development in the 11th Five-Year Plan Recommends" is a programmatic document for equipment management, which emphasized that the construction of resource-saving and environmentally friendly society should be speeded up and recycling economy should be developed more rapidly to realize the goals of per capita GDP doubling that for 2000, unit GDP energy consumption reduced by 20% for 2005 up to 2010. It is required that the China's foreign dependency of technology should decrease from 54% to 30% and increase the contribution rate of science and technology on the economic development from 39% to 70%. All the spirit of the 6th Plenary Session of the 15th Central Committee involves the concrete links of equipment management and maintenance. Green maintenance agrees with developing trend of adjustment and update of the industrial structure in China. Based on the analysis on the green maintenance industry as above, three policy measures are proposed to promote its development.

4.1 To perfect the law system of green maintenance

(1) On one hand, the protective principles of international intellectual property right should be set up. For example, some enterprises should be entitled to remanufacture the discarded automobile components in some condition while the initial automobile manufacturers should be given some preferential policy by the government. The remanufacturing behaviours are regarded as extending the production responsibility for the initial manufacturers. The distinguishing limit among the remanufacturing, repairing and transformation should be defined from legislating. The remanufacturing services should only be provided by some enterprises with a specific qualification and the remanufacturing production should be signed as a special mark. The products quality law should be perfected so that the non-standard remanufacturing products are not able to come into market.

(2) On the other hand, some related laws should be set up to extend the responsibility of manufacturers. The responsibility for products in their different stages of life cycle is necessary to be defined. It is encouraged that the environment-friendly, disassemble and remanufacturable design is used by the initial manufactures to increase the modularization and standardization of products. The remanufacturing idea should be introduced into the products design to decrease the amount of irreplaceable waste when they are discarded. The responsibilities for the producers, middlemen, importers, sellers and consumers in the life cycle of products are necessary to be defined.

4.2 To perfect industrial policy and strengthen industrial management

The administration system of profession admittance should be strictly implemented. For example, the enterprise authentication policy, the product and market supervision policy, technical standard and supervision policy, raw materials source supervision policy and intermediary supervision policy are required to standardize market behaviours of different economic subject in the green maintenance industry.

(1) The profession admittance should be strictly implemented. The qualifying standard is required to be established to define the admittance conditions of production and sale for enterprises. The certification system is necessary to provide to special technologies and special equipment. The environmental standards for the green maintenance should be established by the State Environmental Protection Administration of China in order to prevent the heavy metal pollution, waste liquid pollution, waste solid pollution brought by disassembly, renewing of discarded products.

(2) It is necessary to establish the quality accreditation system for the products. The national

standard for the green maintenance products is required to be established. The remanufacturing products are able to sell only if they obtain the

authentication certificate of compulsory product from the national certificate authority.

(3) It is essential to improve the technological standards and supervision. For example, the scrapping principles and standards for different types products, the general technology and key technology standards for remanufacturing of scrapped products should be established and the record-filing system of large remanufacturing engineering should be implemented.

(4) To perfect the supervision system of raw source materials and recovery system of scrapped products and materials. It is necessary to guarantee the numeric stability and the source reliability of raw materials in qualified enterprises, establish the recovery network of scrapped products and materials, and perfect the importing system of remanufacturing products. Some recovery and processing treatment centres of scrapped products and materials including scrapped automobiles, scrapped computers, scrapped appliance and scrapped tires meeting the environmental requirement and industrial developing trend should be constructed. It is encouraged that some large recovery networks and logistics system and recovery-processing treatment bases be established to increase the recovery ratio of scrapped products and materials.

4.3 To perfect the science and technology policy and promote the technology innovation

(1) It is necessary to increase investment in research and development to perfect the innovation system of green maintenance technology. For example, some research and development centres and scientific research fund are suggested to be established to solve different problems in basic theory and practice on green maintenance technologies. The enterprises are encouraged to master the core technologies and key technologies by using new technologies introduction, cooperative development and so on.

(2) The national public information platform should be established to realize the social omni-directional cooperation. For example, the data sharing system is proposed to perfect the engineering technologies database and realize its sharing in whole society. The trade association, scientific research institution and enterprises are encouraged to develop university-industry cooperation in some key technology fields and increase the transformation efficiency of scientific research achievements.

References

[1] Cheng Xiaoyu. Implementation strategy of green maintenance, Equipment Maintenance and Management,2003,(10):9-10

[2] Gang Maozhi, Zhou Hong. Study on the frame of theory and technology system on the green maintenance. China Surface Engineering, 2006,(10):43-46

*hqcheng@bjut.edu.cn; phone 010-67392556; fax010-67392556; <http://www.bjut.edu.cn/college/xunhuan/index1.htm>; Institute of Recycling Economy, Beijing University of Technology, Beijing 100124, China

wuyufeng@bjut.edu.cn; phone 010-67396263; fax010-67392556; <http://www.bjut.edu.cn/college/xunhuan/index1.htm>; Institute of Recycling Economy, Beijing University of Technology, Beijing 100124, China