

Research on the Energy-Saving Design Idea of Mechanical Design and Manufacturing and Its Automation

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Abstract: With the continuous development of global industry, the field of mechanical design, manufacturing and its automation is facing increasingly severe energy and environmental pressure. In order to solve the problem of energy consumption and environmental pollution, this paper with energy saving design ideas as the core, in the material selection as the research object, by optimizing the material selection, using advanced numerical control technology and green processing technology, put forward a series of solutions, aims to provide reference for mechanical design and manufacturing and automation practitioners, promote the industry towards more sustainable and energy saving direction.

Keywords: Mechanical design and manufacturing; Automation; Energy-saving design ideas

Introduction: Mechanical design and manufacturing and its automation play a vital role in promoting the development of industry. However, with the rapid development, it also faces serious problems in energy consumption and environmental pollution. In order to better solve this contradiction, this paper introduces the idea of energy-saving design into each link of mechanical design and manufacturing, paying special attention to material selection, numerical control technology and green processing process, aiming to improve the efficiency of energy utilization and reduce the environmental burden.

1. Mechanical planning and its automation features

Mechanical planning is a kind of manufacturing process to complete the workpiece processing by mechanical means, and its core characteristics lie in high efficiency, accurate and controllable. First of all, mechanical planning pays attention to precision, through precision mechanical system and advanced control technology, can achieve micron level processing accuracy, to ensure the quality of products. Secondly, mechanical planning has a high degree of automation characteristics, which can automatically perform processing tasks through computer programs, improve production efficiency, and reduce manual intervention. In addition, mechanical planning has the flexibility, can adapt to different processing needs, through the adjustment of procedures and process parameters to achieve multi-variety, small batch production. In general, mechanical manufacturing, through automation and precision machining, has brought about revolutionary changes to the manufacturing industry and promoted the continuous development of industrial manufacturing.

2. Mechanical design and manufacturing and the application of automatic energy-saving design idea

2.1 Optimize the product structure and function

In terms of product structure, adopting lightweight design is a key measure. By using advanced materials with high strength and low density, such as carbon fiber composites, we can reduce the product weight, motion inertia and energy loss on the premise of ensuring the strength. For example, carbon fiber materials are widely used in the aerospace field to make aircraft structures lighter, reduce flight resistance and improve fuel efficiency. Secondly, in terms of product function design, through the application of intelligent technology, accurate control and adaptive adjustment are realized, so as to match the actual working condition requirements to the maximum extent. For example, smart sensors and advanced control systems can monitor the running state of equipment, adjust working parameters in real time and avoid unnecessary energy consumption. In the manufacturing industry, the introduction of programmable logic control (PLC) system realizes the intelligent management of the production line, and the production speed and energy consumption are adjusted on demand^[1]. At the same time, optimizing the product structure and function also includes improving the product maintainability and manufacturability. The modular design makes the parts easy to replace and repair, prolong the product life and reduce the waste. This design concept is in line with the concept of

circular economy, and helps to reduce resource waste and reduce energy consumption.

2.2 Optimize the design scheme

Reasonable selection of power system is an important aspect of optimizing the design scheme. Using efficient electric motor, engine or other power plant, can improve the energy conversion efficiency. For example, instead of the traditional internal combustion engine drive, the choice of electric drive system not only reduces the energy loss, but also reduces the noise and emissions, in line with the trend of modern green and energy saving. At the same time, through system integration and intelligent control, optimized energy management. Advanced adaptive control algorithm, predictive maintenance and energy recovery technology will enable the system to automatically adjust the operating state according to the actual load and working conditions to avoid unnecessary energy consumption. For example, factory automation systems in intelligent manufacturing can adjust the operating status of equipment in real time according to production requirements, and minimize energy waste during idle periods. In terms of structural design, adopting the optimized mechanical structure and transmission system is also an important strategy. By reducing the friction loss and improving the transmission efficiency, the energy loss in the power transmission process can be reduced. Advanced materials and structural design such as bearings and transmission belts are adopted to reduce the internal resistance of the system and improve the overall operation efficiency^[2]. In addition, considering the energy consumption in the life cycle of the product, the whole life cycle energy saving of the design scheme is realized from the perspective of sustainability. This includes product manufacturing, operation, maintenance and scrap stages, comprehensive consideration of the energy efficiency of the system, to promote the development of circular economy.

2.3 Use of virtual design technology and mechanical equipment automation technology

Virtual design technology plays a key role in the product development process. With tools such as computer-aided design (CAD) and computer-aided engineering (CAE), engineers are able to simulate, analyze, and optimize products in a virtual environment. For example, in aircraft design, hydrodynamic simulation can optimize the aircraft shape, reduce air resistance, and reduce fuel consumption. Virtual design technology enables engineers to deeply optimize the system before the actual manufacturing, thus reducing the cost of trial and error and improving the accuracy of the design. At the same time, the application of mechanical equipment automation technology can achieve a high degree of intelligent and efficient in the manufacturing process. Automated production lines can use sensors, machine vision and machine learning technologies to monitor and adjust production parameters in real time to adapt to different working conditions and needs, thus reducing energy waste and fluctuations in production efficiency. For example, an automobile manufacturer introduced an automated assembly line to quickly and accurately assemble parts through intelligent robots, improving production efficiency and reducing the rejection rate. The integration of virtual design technology and mechanical equipment automation technology is also reflected in the maintenance and operation stage. Through remote monitoring and maintenance systems, predictive maintenance can be performed before equipment problems, reducing downtime and improving equipment stability and reliability.

2.4 Optimize the material selection in mechanical products

Using high-strength and lightweight materials is a common strategy to optimize material selection. For example, aluminum alloy, compared with traditional steel, has higher strength and lower density, and can be used in automobile, aircraft and other fields, to reduce the weight of the vehicle and improve fuel efficiency. At the same time, fiber reinforced composite materials are also an important choice for lightweight design, such as carbon fiber composites are widely used in aircraft, automobile and other fields to reduce the structural quality and improve the mechanical performance. Secondly, considering renewable materials and recycling is an important way to achieve sustainable development. By selecting biodegradable materials, recycled materials or materials that can be easily recycled, resource consumption is reduced and the burden on the environment is reduced. For example, some plastic products use biodegradable materials to help reduce the environmental impact of plastic waste. In addition, optimizing the surface treatment and coating technology is also the way to improve the material performance. By using the coating with corrosion resistance and wear resistance, the life of the material can be extended and the energy

waste caused by the material aging can be reduced. For example, the use of advanced surface coating technology, such as nano-coating, can form a protective film on the surface of mechanical parts, improve wear resistance, reduce friction resistance, and reduce energy consumption^[3]. Finally, through the life cycle assessment, comprehensively consider the energy consumption and environmental impact of materials in the procurement, production, use and scrapping stages, and select the materials most consistent with the concept of sustainable development.

2.5 Promote the energy management system

The establishment of a comprehensive energy monitoring system is a key step in promoting the energy management system. Through the introduction of high-precision sensors and monitoring equipment, real-time monitoring of equipment operation status, energy consumption and other data, to form a comprehensive energy use data, to provide a basis for the subsequent energy management and optimization. For example, the installation of power monitors, gas flowmeters and other equipment on industrial production lines can monitor the consumption of electricity and gas in real time. Secondly, the advanced data analysis and artificial intelligence technology are used to process the monitoring data. Through big data analysis, the energy management system identifies potential energy waste points, and conducts predictive analysis through artificial intelligence algorithm to optimize the production plan and equipment operation parameters. For example, through machine learning algorithms, the system can learn the working mode of the device, realize the dynamic adjustment of the device performance, and improve the overall energy efficiency. Third, implement the intelligent control strategy of the energy management system. By integrating PLC (programmable logic controller), SLC (monitoring and data acquisition system) and other automation technologies, realize intelligent control of the production line. The energy management system can automatically adjust the parameters of the operation state and production speed of the equipment according to the production demand to avoid unnecessary energy waste. For example, an intelligent lighting system can automatically adjust the lighting intensity according to the actual lighting situation in the working area to reduce energy consumption. In addition, the promotion of energy management systems also requires staff training and awareness improvement. By training employees to use and understand the energy management system, stimulate their awareness of energy conservation, encourage them to participate more actively in energy management and optimization work, establish incentive mechanisms, and reward employees for innovation and proposals in energy conservation.

Conclusion: With the introduction and popularization of advanced technology, the field of mechanical design and manufacturing and automation also needs continuous innovation and optimization. Building a green and efficient machinery manufacturing system is our goal. Actively explore the innovation and application of energy-saving design ideas, strengthen the green processing technology and other measures, will lay a foundation for the realization of sustainable development. We should strengthen technology research and development, improve the independent innovation ability of the industry, and make contributions to the overall development of the field of mechanical design and manufacturing and automation.

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