

Selection and Application of Mechanical Materials Based on the Concept of Machine Design

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Abstract: Materials in machine design are taken as main research object to implement sustainable development from the perspective of the selection and application of the actual situation of materials. The significance and principles of material selection are analyzed and discussed in detail to demonstrate the significance of selection and application of materials in machine design to the machinery production, processing, energy saving, emission reduction and environmental protection.

Keywords: Machine design; Mechanical materials; Selection; Application

1. Introduction

With the rapid development of China's economy, especially the rapid development of machinery manufacturing industry vigorously promote the development of China's industrialization, the requirements of machinery manufacturing in all aspects are constantly getting higher. In the process of machine manufacturing, the selection and application of mechanical materials are two of the most important parts. The selection of mechanical design materials determines the quality of the products of machine design and can realize the sustainable development of machine manufacturing. Therefore, the selection and application of mechanical materials have always been a concern of the machine manufacturing industry. During the process of selecting materials, the scope of use and practicality of materials should be considered. And the environmental and economic benefits of materials should also be considered to save production costs and protect the environment. Only in this way can sustainable development of economy and environment in China's machinery industry be realized, so as to improve the quality of people's life and ecological environment and contribute to the development of China's green economy.

2. Analysis of the Significance of Mechanical Material Selection in Machine Design

Since the reform and opening-up, machinery manufacturing has been an indispensable part of China's development, especially machine design. In the process of machine design, selection and application of materials are particularly important. With the rapid development of modern society, people have higher and higher requirements on mechanical products, especially on the quality

of mechanical materials. Only by selecting the right mechanical materials, can products in line with the modern society be produced, which shows the importance of mechanical materials. As a consequence, the selection of mechanical design materials must be considered in all aspects. The selected materials should be applicable and practical in machine design and should not cause secondary pollution to the production environment and damage the local production environment and production resources. Therefore, in the process of selecting materials, environmental protection and economic applicability of materials must be taken into account. Constantly improvement in the quality of mechanical materials will play a positive role in China's machinery manufacturing industry, which will improve the quality of life of Chinese people, vigorously enhance China's comprehensive strength and promote China's sustainable and healthy development.

3. Classification of Materials in Machine Design

Metallic material. Metallic materials dominate in China's mechanical processing. The majority of materials are metal, and they are even used in the whole process of processing, occupying almost 100%. The biggest advantages of metal are its high hardness and low cost, which can meet the requirements of all aspects of machine design, so it is widely used in the production process. Alloys mixed by two metals have excellent properties and are of great concern in machining.

Ceramic materials. The main components of ceramic materials are silicon nitride and silicon carbide, which are characterized by chemical corrosion resistance, high hardness and low density. In the process of mechanical

construction, ceramic materials are often used for the components with strong sealing property. However, ceramic materials are costly, fragile and brittle.

Polymer materials. Polymer materials are similar to synthetic fibers. They have a wide range of sources, which can be extended to many fields. Their biggest advantage is that its preparation process consumes little energy and can even be extracted from natural gas.

Composite material. Composite material refers to the final product of two or more materials fused by chemical or physical methods. Composite materials can be selected according to the different construction requirements of machining. In fact, alloy material is also a kind of composite material. There are many kinds of composite materials with different properties, which are suitable for various machining requirements. As a result, composite materials are highly praised.

4. Selection and Application of Materials in Machine Design

Load type material selection. Many designed components or materials are not applicable mainly due to the fact that they do not have strong loading capacity and cannot give full play to the advantages of the components or materials. Therefore, components or materials should be selected according to their loads in the phase of machine design. The most common method is carburizing low carbon steel or tempering medium carbon steel.

Select low energy-cost and less polluting materials. No matter which kind of material is selected, it is required to be low energy-cost and less polluting at first. But it is not applicable to the material that needs to be preheated in advance, because for the material that is preheated in the later stage, its life time will be shortened with any carelessness or its performance will disappear. And preheating materials in the late stage will pollute the air, especially the surrounding environment of machining, so the most suitable mechanical material can perform its best both in hot rolling and cold drawing states. If it is inevitable to use the material need to be preheated, use less as far as possible or select materials need less preheating steps. The most common method is to use low hardenability steel to forge mechanical parts, so that the mechanical material will form a layer of hardenability after forging.

Service condition and failure mode of parts. The force condition of mechanical parts in the product should be analyzed, namely, their loads, including stretch, compression, torsion, bend and so on. And the nature of the load should also be considered, such as static load, impact load, variable load and so on. In addition, the using environment of the parts, such as temperature and media, and special requirements, such as conductivity, insulation, magnetic, thermal conductivity and so on, should also be taken into consideration. Analyze the failure form of

parts. Parts will fail to perform normally due to performance deficiency. Analysis of the failure form of parts will indicate the performance that makes them fail, which is the main basis for the selection of materials. For example, it has long been believed that crankshafts mainly bear high impact force and wear, but failure analysis results show that the failure of crankshafts is mainly fatigue failure, so the quality and life of crankshafts will be greatly improved by taking fatigue strength as the main design basis. Determine performance indicators and values. After determine the required performance of parts through the analysis of failure form, it is an extremely important step to transfer the required performance to experimental indicators and values. Problems of material selection according to mechanical properties should be paid attention. After the mechanical property indices and numerical value required by the parts can be determined, material selection can be carried out. Proper application of strengthening methods to give full play to material potential, material selection and strengthening will be combined with a comprehensive consideration of the two, while the manual and relevant materials should be correctly used, especially the determination conditions of manual data. Properly use hardness index. Hardness index is commonly used as indicators to control the material performance, and hardness is commonly used in the technical conditions to show the requirements of mechanical properties of the metal parts. But the hardness index has its limitations, so when the hardness value is put forward in the design, the heat treatment process should be clearly regulated. In addition, other mechanical performance should be required of important parts.

Parts are made of different engineering materials through processing and manufacturing. Therefore, the technical properties of materials, namely, the degree of difficulty in processing qualified parts, is also an important issue to be considered the selection of materials. In material selection, compared with the performance, process performance is in a secondary position, but in some cases, such as batch production, process performance becomes the main basis for material selection. The technological performance of materials has a direct impact on the processing and production of parts. The main technological performance includes casting performance, forging performance, welding performance, cutting performance and heat treatment performance.

From the perspective of material forming technology, if it is casting, the requirements of the material involve shrinkage, fluidity, segregation, inhalation and other thermal crack tendency, so it is best to choose eutectic composition and its near alloy. If it is forgings, stamping parts, the requirements of the material involves post-forging cooling, stamping, malleability and cold upsetting, and it is best to choose the alloy of solid solution. If it is welding parts, the requirements of the material involve weld-

ing joint performance and sensitivity, and it is best to choose low carbon steel and low alloy steel. The requirements of technology for heating process include oxidation decarburization tendency, tempering brittleness tendency, superheat sensitivity, hardenability and deformation and cracking tendency.

Take recycling measures. Due to the wide application of metal materials in mechanical design and the wide variety of metal materials, there are hundreds of steel materials. Especially in the process of mechanical design and application, a variety of metallic materials need to be mixed and used, which greatly increases the difficulty of recycling and seriously affects the recycling of waste. Therefore, in order to improve the recycling rate of waste, it is necessary to conduct different kinds of waste screening, especially in-depth analysis of the recyclability of waste. Generally speaking, the basic elements of the material are few and have the uniqueness. The fewer the constituent elements are, the higher the recycling utilization rate is.

Select economical materials. Economic cost is also an important aspect in the selection of machine design materials. In the process of machine design, designers need to analyze the specific steps in the design process and combine the design characteristics of each process to select the most cost-effective mechanical materials, maximize the use value of materials, and finally determine the basic requirements of mechanical design. Different machine design materials have different features of performance, so the performance of materials should be understood in detail to select highly cost effective and economical materials, which are required to meet the standards of machine design and master the basic content of the selected materials. In addition, selection of economical materials should be on the basis of the overall budget of machine design engineering. There are two main principles. The first one is to meet the requirements of the machine design engineering and all kinds of materials are required to be in low price. The second one is to ensure that the selected materials are the most cost-effective, economical and applicable. In particular, the kind of mechanical materials that can be recycled should be given priority to be selected to reduce energy consumption from the source, effectively control the cost of machine design process and increase the economic benefits of the whole mechanical project.

Comply with the principle of sustainable development of the country. The essence is to realize the recyclable development of economic resources. In order to realize low energy-cost, designers should dig into the basic requirements of mechanical design, get familiar with the potential content of mechanical materials, analyze the basic characteristics of mechanical materials and how to use and maximize the best performance of mechanical materials. Less-polluting mechanical engineering protects the

natural and saves environment energy, which is an important concept of modern society's development and an important policy of sustainable development in China. With the rapid development of China's economy, people have further requirements for the surrounding living environment. Therefore, mechanical engineering needs to combine energy consumption and environmental pollution, effectively control the energy consumption of mechanical materials, improve the utilization rate of materials, reduce environmental pollution, take sustainable development as the guide to select materials that protect the environment and save energy and minimize the application of non-renewable resources in various fields.

5. Matters Needing Attention

In mechanical engineering, the external loading force must be paid attention to when selecting materials. External loading force in mechanical design can make the material surface appear bending and other phenomena. Serious bend will lead to the loss of the use value and performance of the whole material. Therefore, selected materials should be well processed because good manufacturing technology creates mechanical materials with good performance. Or mechanical materials with uniform surface distribution or high stress tolerance should be selected.

Pay attention to the practicality of mechanical materials. The primary standard of selecting mechanical materials is the practicality of materials. Mechanical engineering has a variety of processing links, and each processing link has its own different requirements and standards. For instance, the welding environment needs mechanical materials that must meet the welding material standards and sensitivity to welding, and the forging environment needs mechanical materials to adapt to various stringent requirements in the forging process. Therefore, the selection of mechanical materials should meet the practical requirements of mechanical engineering. In addition, economical requirements of mechanical materials also need to be considered. The overall budget of mechanical design or stage budget should be analyzed and reduce material costs and machining costs on the basis of meeting the standards of mechanical design standards as far as possible, so as to ensure the healthy development of machine processing.

6. Conclusion

With the continuous progress of China's modern society, China's machine design industry has made important achievements. The selection and application of mechanical materials is an important prerequisite for the mechanical engineering industry, and it is also of great significance to the healthy development of the mechanical industry. Energy-saving and environmentally friendly materials should be selected. The selection of materials is re-

quired to meet the requirements of machine design and comply with the view of sustainable development, which is positive to the machine processing industry of China.

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