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Research on the Development Direction and Path of the Chemical New Materials Industry under the Background of Carbon Peaking and Carbon Neutrality

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Abstract: In recent years, with the implementation of the "carbon peaking and carbon neutrality" development policy, the chemical new materials industry has seized new development opportunities, accelerating its transformation, development, and upgrading process. From the perspective of carbon peaking and carbon neutrality, this article first analyzes the advantages and disadvantages of China's industrial development, then conducts a detailed analysis of the development direction of the chemical new materials industry, and finally proposes effective paths for the development of this industry. The study hopes to promote the high-quality and sustainable development of the chemical new materials industry and provide a reference for peers.

Keywords: Carbon peaking and carbon neutrality; Chemical new materials industry; Development direction; Path

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1. Introduction

The "carbon peaking and carbon neutrality" goals and actions have a significant impact on China's chemical new materials industry. However, as the chemical industry is a major pillar of the national economy, for a long time, it has also been a high-emission and high-pollution industry. Therefore, it is particularly important to achieve industrial upgrading in the development of this industry. First, product upgrading should be carried out to achieve high-quality products, reduce energy consumption, and enhance confidence in implementing the "carbon peaking and carbon neutrality" goals. Second, attention should be paid to the development of green and low-carbon products, which is a key way to promote industrial development and also plays an important role in reducing the carbon emission rate [1]. Therefore, against the background of carbon peaking and carbon neutrality, relevant personnel should focus on researching the development paths and efficient methods of the industry to ensure its

high-quality, green, and environmentally friendly development.

2. Advantages and disadvantages of domestic industrial development

2.1. Advantages

First, China has a solid and stable chemical industry foundation, which can not only provide sufficient resource supplies for national economic development but also has a complete industrial chain. For example, the petrochemical industry, a part of the chemical industry, has a large scale and can continuously supply a large number of raw materials for new industries. Second, the potential demand of the chemical industry is huge. Due to the continuous development and rapid expansion of emerging industries, their actual demand shows multi-level and high-demand characteristics, constantly expanding the market coverage. Third, in recent years, the investment in technological innovation has been increasing, and technological innovation has achieved a leap-forward development, which further demonstrates the industry's innovation ability [2].

2.2. Disadvantages

First, the contradictions in the industrial structure are prominent. There is a shortage of high-quality products and an excess of low-end products, resulting in excessive dependence on imports for high-end products in China. Second, the technological innovation ability still has obvious deficiencies. Although the investment in technological innovation has increased in recent years, compared with advanced countries, the differences in high-end products and individual processes are particularly significant, weakening the international competitiveness of the chemical new materials industry. Third, the energy utilization rate is relatively low. In the specific production process, problems such as energy consumption and waste treatment are relatively serious. Green and low-carbon technologies should be vigorously studied and applied to improve the sustainable development level of the industry [3].

3. Development directions of the chemical new materials industry against the background of carbon peaking and carbon neutrality

3.1. High-performance orientation

3.1.1. Upgrading basic materials to high-performance ones

By means of developing new catalysts, upgrading technologies, and enhancing functions, traditional basic products such as polyethylene, polypropylene, and polyvinyl chloride are upgraded into high-end products to achieve product differentiation. Take polyethylene as an example. By using a new catalyst system and polymerization process, the molecular structure can be strictly controlled to produce high-quality resin products with high strength, good toughness, and excellent corrosion resistance. These products are widely used in high-end packaging, the automotive industry, and pipe production. This not only improves product quality and extends product lifespan but also reduces raw material consumption and CO_2 emissions [4].

3.1.2. Developing high-performance materials

Rapidly promote the development of high-performance products represented by high-density polyethylene membrane materials, various special synthetic rubbers, and special film materials to meet the needs of emerging markets such as aerospace and electronic communication. In the aerospace field, carbon-fiber composites, known for their low density, high hardness, and high-temperature resistance, are the first choice for manufacturing

important parts such as aircraft bodies and wings. They can reduce flight weight and power consumption, greatly reducing emissions. In the electronic communication field, functional thin materials such as polarizers and image correction layers play an important role in improving the application efficiency of electronic screens, promoting the miniaturization and high efficiency of electronic products.

3.2. Green and low-carbon orientation

3.2.1. Greening of raw materials

Increase the coupling between green hydrogen and electricity and the chemical production process, and raise the proportion of sustainable and low-carbon resources such as biomass and carbon dioxide. This reduces excessive reliance on traditional fossil fuels. For example, green hydrogen produced by electrolyzing water can be used in the processes of hydrocracking and hydro-purification, which can reduce the carbon dioxide emissions from hydrogen production using traditional fossil resources. In addition, biomass can be used to produce new chemical materials such as bio-based plastics and bio-based fibers. During the growth process of biomass, it absorbs carbon dioxide, and its carbon emissions during the life cycle are very low [5].

3.2.2. Greening of the production process

Adopt green production processes, such as technologies to improve energy efficiency, reduce pollution, and enhance resource utilization efficiency. Some chemical companies have adopted advanced separation technologies, reactor designs, and automated management solutions to accurately monitor production and operate under optimal conditions, enabling efficient energy use and reducing harmful emissions. At the same time, study green chemical process methods, such as atom-economic reactions, which can convert the atomic energy of reactants into the target product as much as possible, reducing by-products, subsequent processing costs, and environmental pollution.

3.2.3. Intelligentization

Promote the development of intelligent material technology to achieve multi-level integration and revolutionary applications. Intelligent materials can respond to environmental stimuli and can be applied in areas such as spacecraft intelligent self-control, intelligent biology, medical health, and automotive collision beam repair. Due to the property that shape-memory alloys can change their deformation state under the action of temperature and pressure and return to their original state, they can be used to create intelligent devices such as vascular stents. At normal temperature, the vascular stent can maintain a certain shape to maximize its supporting effect. Intelligent glass can change its permeability according to the intensity of external environmental light, so it can be applied in building structures to achieve the goals of energy conservation and emission reduction, and comfortable living [6].

4. Development paths of the chemical new materials industry against the background of carbon peaking and carbon neutrality

4.1. Driven by technological innovation

4.1.1. Increasing R&D investment

Develop intelligent material technology and ensure its disruptive application and innovative introduction. Intelligent materials have the function of responding to the environment and are applied in fields such as spacecraft adaptive control, intelligent biology, medical devices, and automotive bumper repair. For example, shape-memory materials can return to their original shape according to temperature and pressure, so they can be used as variable-

shape medical devices (such as vascular stents), which can take a specified shape at normal body temperature to provide vascular support. Intelligent glass can automatically adjust the light according to the intensity of external light, so building glass with this characteristic can achieve the goals of energy conservation and comfortable living [7].

4.1.2. Strengthening industry-university-research cooperation

Strengthen the innovative collaborative linkage and interaction among the upstream, mid-stream, and downstream links, promote the integrated development of scientific research, education, industry, and other fields, and establish a new collaborative innovation ecological environment for industrial development. Give full play to the research potential of universities and research institutions, and accelerate the transformation of scientific research achievements into practical technologies and industrialization. Universities mainly focus on basic science and can provide new theories and technical ideas for the chemical new materials field. Research institutions mainly focus on the development of practical technologies and can transform the theoretical research results of universities into practical technologies and products. Enterprises, as the main body of the market, have the strength to mass-produce, market, and use these research results. Through the collaborative innovation of industry, university, and research, an innovation chain from basic research to technology research and development and industrial application can be formed [8].

4.1.3. Utilizing new technologies such as artificial intelligence

Actively apply cutting-edge technical means such as "AI for Science" to significantly shorten the research and development cycle, reduce research and development costs, and push research effectiveness to a new level. For example, by using AI scientific research tools, all operation process links, such as reading materials, numerical simulation, practical operation, and interdisciplinary integration, can be covered, improving research efficiency. In addition, by using artificial intelligence technology to analyze massive data and obtain information to infer the relationship between physical properties and structures, it can provide directions for the production of new materials. At the same time, artificial intelligence can also automatically control experimental instruments and analyze measurement data in real-time during laboratory operations, quickly searching for the most suitable experimental parameters and greatly improving the development efficiency of new materials [9].

4.2. Optimizing the industrial structure

4.2.1. Eliminating backward production capacity

In the chemical new materials industry, processes and products with high pollution, high energy consumption, and no added value should be eliminated to promote the industry's development towards intelligence and greenness. Government departments should also improve the standards and policies they formulate to encourage industries and enterprises to actively innovate their production structures. Larger enterprises can innovate and upgrade their industries and technologies, increase the production of high-end products, and continuously reduce emissions and energy consumption. Smaller enterprises can directly eliminate backward industrial chains [10].

4.2.2. Developing high-end products

Increase the variety and specifications of materials such as polyurethane and polyamide, accelerate the development of high-end polyolefins, electronic chemicals, bio-based materials, and other products, and improve the self-sufficiency rate of high-end chemical new materials to meet the needs of key materials for domestic

strategic emerging industries. In the field of electronic chemicals, increase R&D and production investment in high-purity reagents, photoresists, electronic specialty gases, and other products to break the monopoly of foreign enterprises and achieve import substitution. In the field of bio-based materials, utilize China's rich biomass resources to develop bio-based polyesters, bio-based polyamides, and other products, expand the raw material sources of chemical new materials, and reduce dependence on fossil energy [11].

4.2.3. Building industrial clusters

Newly built chemical industrial material parks can gather relevant upstream and mid-stream enterprises to form a complete upstream-downstream industrial chain and promote the coordinated development of the industrial chain. It is necessary to strengthen the construction of park infrastructure and improve the quality of public services to create a good development space for enterprises in the park. In addition, enterprises in the park should be encouraged to increase investment in scientific and technological research and development and improve productivity levels to promote the development of the industrial chain to a higher level and enhance the competitive advantage of the entire industry group. Finally, it is necessary to strengthen exchanges and cooperation with global chemical new materials industry clusters, actively learn advanced foreign technologies and management experience in the development of the chemical new materials industry, and gradually promote the development of China's chemical new materials industry clusters into international-level clusters [12].

4.3. Guided by policy support

4.3.1. Formulating relevant policies

Relevant government departments should formulate supporting policies according to the specific development of each industry, encourage them to increase technological innovation and R&D efforts, and promote their development towards the path of green, low-carbon, and environmental protection. For example, for enterprises with high costs in environmental protection processing and scientific and technological development, the government can provide subsidies in the form of tax rate reduction or tax exemption. Special funds can be set up to reward a large number of companies for actively researching and developing environmental-protection and scientific-and-technological innovation projects. To reduce the economic pressure on enterprises, industrial funds can be used to provide capital investment for enterprise operations, and guide the funds to focus on R&D projects of new materials [13].

4.3.2. Improving the standard system

Establish and improve the specification and standard system and certification system for chemical new materials to standardize the market, improve product quality and safety levels, and promote industrial development. Formulate unified quality requirements, test procedure requirements, and environmental requirements; clearly define product performance requirements, quality requirements, and environmental requirements; strengthen product approval control, and only approved products can be put on the market for sale, which protects the interests of customers and encourages enterprises to improve product quality and scientific and technological levels.

4.3.3. Strengthening international cooperation

Actively participate in the formulation of international standards, strengthen cooperation and exchanges with international advanced enterprises, introduce foreign advanced technologies and management experience, and enhance the international competitiveness of China's chemical new materials industry. China should organize

industry experts and enterprise representatives to participate in the activities of international standard-setting organizations, integrate China's technical achievements and practical experience in the field of chemical new materials into the formulation of international standards, and improve China's voice in the formulation of international standards. Enterprises should be encouraged to carry out cooperation projects with well-known international chemical enterprises. Through technology introduction, joint ventures, and other means, learn foreign advanced technologies and management models to promote the international development of China's chemical new materials industry [14].

4.4. Recycling of resources

4.4.1. Developing the circular economy

Develop and adopt re-processing technologies for environmentally friendly polymer materials, recycle and reuse waste, which is conducive to sustainable utilization, reduces the demand for raw materials, and helps to reduce greenhouse gas emissions. Some organizations use physical recycling, chemical recycling, and other means to convert used polymer materials (plastics or rubbers) into primary substances or products that can be reprocessed and used. For example, physically recycled waste plastics can be reused to make plastic products after being cleaned, crushed, and pelletized. Chemical recycling means decomposing the above-mentioned waste polymer materials into monomers or oligomers, which can be used as new raw materials for re-synthesis [15].

4.4.2. Strengthening cooperation among enterprises

Build an enterprise-sharing system that can not only achieve the sharing and comprehensive application of different enterprise assets but also ensure cost reduction and efficient utilization. For example, in an industrial park, different enterprises are required to cooperate. The waste of one enterprise can be used as the production resources of another enterprise. The co-built and shared platform between the two can ensure the optimal distribution of all relevant information. In addition, an information-sharing platform should be built among companies. Each company on the platform actively shares information, which can increase the degree of cooperation among companies, is conducive to better promoting the resource recycling of each company, and thus promotes the sustainable development of the economy [16].

5. Conclusion

In general, under the background of carbon peaking and carbon neutrality, the opportunities and challenges faced by the chemical new materials industry are unprecedented. Through in-depth research on the industry's development direction, it can be realized that high-performance, green and low-carbon, and intelligent development are gradually becoming an inevitable trend. In this regard, based on a clear understanding of the existing problems, enterprises should actively take paths such as technological innovation-driven, industrial structure optimization, policy-support-guided, and resource-recycling-based. Only in this way can people ensure the sustainable development of the chemical new materials industry against the background of carbon peaking and carbon neutrality and make greater contributions to national economic construction and environmental protection.

Disclosure statement

The author declares no conflict of interest.

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