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Research on the Development Status and Challenge of Magnetic Refrigeration Field

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Abstract: The present situation and challenges of magnetic refrigeration are discussed in this paper. As a cutting-edge refrigeration technology based on magnetothermal effect, magnetic refrigeration technology has the advantages of high efficiency, environmental protection, low noise and long life, and is regarded as an important development direction in the future refrigeration field. This paper first introduces the basic situation of magnetic refrigeration system, market supply and demand analysis, industry competition and technical progress, and then analyzes the challenges faced by magnetic refrigeration technology and countermeasures, and prospects its future development. The research in this paper aims to provide reference for the further development and application of magnetic refrigeration.

Keywords: Magnetic Refrigeration Technology; Magnetic Refrigeration System; Market Supply and Demand; Industry Competition; Technical Challenge.

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1.Introduction

As a cutting-edge refrigeration technology, magnetic refrigeration system is based on magnetothermal effect. The technology affects the magnetic moment arrangement inside the magnetic material by regulating the magnetic field, and then realizes the absorption and release of heat to achieve the purpose of cooling or heating. Magnetic refrigeration systems are not only efficient, but also environmentally friendly, demonstrating their great potential in the field of future refrigeration. In the product spectrum of magnetic refrigeration system, magnetic refrigerator, magnetic refrigeration material and magnetic refrigeration controller constitute the core three elements. As the core equipment of the system, the working principle of the magnetic refrigerator is to use the thermal effect of the magnetic refrigeration material under the change of the magnetic field to achieve fast and efficient refrigeration effect. Magnetic refrigeration material is the key to this technology, and its performance is directly related to the refrigeration efficiency. The magnetic refrigeration controller plays the role of “brain” and is responsible for accurately controlling the changes in the magnetic field to ensure the stable and efficient operation of the entire refrigeration system.

Since the beginning of the 20th century, the development of magnetic refrigeration technology has experienced a long process from basic theoretical research to experimental technology verification. With the cross integration and continuous progress of material science, magnetism and refrigeration technology, magnetic refrigeration system has gradually moved from the laboratory to the market, and achieved a breakthrough in commercial application. Especially in recent years, with the increasing attention of the world to energy conservation and environmental protection, magnetic refrigeration technology has

begun large-scale application in some specific fields with its unique green and efficient characteristics [1].

At present, the magnetic refrigeration system industry is in a stage of vigorous development. As technology continues to advance and mature, the market size is constantly expanding. Especially in the context of increasing requirements for environmental protection and energy saving worldwide, magnetic refrigeration technology as a new and efficient refrigeration method, its market demand is growing. At the same time, major enterprises and research institutions in the industry are also actively investing in research and development to promote the development of magnetic refrigeration technology to higher efficiency, lower cost and wider application fields [2].

2.Analysis of Industry Chain Structure

Magnetic refrigeration system industry as an emerging industry, its industrial chain structure is complex and diverse, covering from upstream raw material supply to midstream equipment manufacturing, and then to a wide range of downstream applications.

2.1 Upstream Industry

Supply of core materials and components. Magnetic refrigeration material as the core, its performance directly determines the refrigeration efficiency, is a key link in the industry chain. High-quality magnetic refrigeration materials can effectively improve the energy efficiency of refrigeration systems, reduce energy consumption, and play a vital role in promoting the development of the entire magnetic refrigeration system industry; Electronic components and machining provide the necessary technical support and supporting services for the manufacture of magnetic refrigeration equipment.

2.2 Midstream Industry

Technology research and development, equipment manufacturing and sales. Technology research and development is the core competitiveness of the midstream industry, only continuous innovation, in order to introduce more efficient, more environmentally friendly magnetic refrigeration equipment; Equipment manufacturing and sales are directly related to the market size and economic benefits of the magnetic refrigeration system industry.

2.3 Downstream Industry

A wide range of applications and market demand. Magnetic refrigeration covers many fields such as aerospace, medical treatment, electronics, refrigeration and air conditioning. With the continuous promotion and application of magnetic refrigeration technology, the demand of downstream industries will continue to grow, providing a broad space for the development of magnetic refrigeration system industry. Especially in some high-tech fields, such as aerospace and medical fields, magnetic refrigeration technology has a particularly broad application prospect. These fields have extremely high requirements for refrigeration equipment, and magnetic refrigeration technology can just meet these needs, so the future application of magnetic refrigeration systems in these fields will be more extensive [3].

3.In-Depth Analysis of Magnetic Refrigeration System Market Supply and Demand

In the context of the gradual enhancement of global environmental awareness, the green transformation of refrigeration technology has become an inevitable trend in the development of the industry. Magnetic refrigeration system, with its energy-saving and environmentally friendly characteristics, is gradually becoming the new darling of the market, and its demand has shown a continuous growth trend. The drive of environmental protection policy is one of the important factors for the growth of magnetic refrigeration system market demand. With the increasing attention of governments to environmental protection, traditional refrigeration technology is facing increasingly strict supervision due to high energy consumption and environmental pollution. As a representative of green refrigeration technology, magnetic refrigeration system's low energy consumption and pollution-free characteristics just meet the requirements of environmental protection policies, so it has been widely concerned by the market [4].

3.1 Market Size and its Growth Trend

With the continuous maturity of magnetic refrigeration technology and the expansion of application fields, the market scale is constantly expanding. Especially in the context of increasing requirements for environmental protection and energy conservation worldwide, the market demand for magnetic refrigeration technology is growing. It is expected that the

magnetic refrigeration system market will maintain a steady growth trend in the next few years. At the same time, consumers also need to pay attention to the demand for magnetic refrigeration systems.

Magnetic refrigeration system has the characteristics of high efficiency and energy saving, can significantly reduce energy consumption, in line with the concept of energy conservation and environmental protection in modern society; Magnetic refrigeration system adopts environmental protection medium as heat transfer fluid, no pollution, no emission, in line with environmental protection requirements; Magnetic refrigeration system has a long service life, can reduce the frequency of equipment replacement, reduce maintenance costs; Low noise is a major advantage of magnetic refrigeration system, magnetic refrigeration system in the working process of low noise, can provide a comfortable use environment.

3.2 Comparative Analysis of Market Demand in Various Fields

The application requirements of magnetic refrigeration system in different fields show different characteristics. In the field of aerospace, magnetic refrigeration systems can meet the needs of refrigeration in high temperature environments to ensure the normal operation of equipment; In the medical field, magnetic refrigeration systems can provide a stable low temperature environment for the storage of biological samples and medicines; In the field of electronics, magnetic refrigeration systems can be used to cool electronic equipment and components to improve their performance and stability; In the field of refrigeration and air conditioning, magnetic refrigeration systems can provide efficient and environmentally friendly refrigeration effects to meet people's pursuit of a comfortable living environment [5].

3.3 Overview of Market Supply

At present, the supply of magnetic refrigeration system market mainly comes from some well-known enterprises at home and abroad. These companies have rich experience and strength in technology research and development, manufacturing and sales, and can provide high-quality magnetic refrigeration system products and services. With the continuous growth of market demand, these enterprises are also constantly expanding production scale and improving production efficiency to meet the needs of the market. The core production enterprises of magnetic refrigeration system industry mainly include some well-known enterprises at home and abroad, such as Vacuumschmelze, BASF, Samsung, Toshiba, Haier, Gree, etc. [6]. These companies have rich experience and strength in technology research and development, manufacturing and sales, and can provide high-quality magnetic refrigeration system products and services. In terms of capacity layout, these enterprises have established production bases and sales networks in different regions according to market demand and their own strength to ensure timely supply of products and effective coverage of the market.

4.Product Supply Structure and Characteristics

The product supply structure of magnetic refrigeration system mainly includes magnetic refrigerator, magnetic refrigeration materials and magnetic refrigeration controller and other core elements. These products have the characteristics of high efficiency, environmental protection, low noise and long life, and can meet the application needs of different fields. At the same time, with the continuous progress of technology and the constant change of the market, the product supply structure of magnetic refrigeration system is also constantly optimized and adjusted to meet the market demand and development trend; At present, the supply and demand situation of the magnetic refrigeration system market is in short supply. With the continuous growth of market demand and the continuous progress of technology, the supply capacity of the magnetic refrigeration system market is also constantly improving. It is expected that in the next few years, the supply and demand situation of the magnetic refrigeration system market will be more balanced, and the market size will continue to maintain stable growth. At the same time, with the continuous innovation of technology and the continuous expansion of application fields, the magnetic refrigeration system market will usher in more development opportunities and challenges.

5.Magnetic Refrigeration System Industry Competition

5.1 Brief Introduction of Industry Competition Pattern

The competitive pattern of the magnetic refrigeration system industry shows the characteristics of diversification and multi-level. Well-known enterprises at home and abroad have entered this field, and compete for market share through competition in technology research and development, manufacturing and sales. At the same time, the technical level and strength of

different enterprises differ greatly, which leads to a certain difference and imbalance in the market competition pattern. In the magnetic refrigeration system industry, some key competitors have a high level of technology and market share. These enterprises improve their competitiveness and market position through continuous innovation and expansion of application fields. For example, Vacuumschmelze, BASF, Samsung and other internationally renowned companies with advanced technology and rich experience, in the field of magnetic refrigeration materials has a high competitiveness; Haier, Gree and other domestic enterprises through continuous research and development and innovation, improve the performance and quality of magnetic refrigeration system, won market recognition.

5.2 Market Share and Its Changing Trend

The market share of the magnetic refrigeration system industry is constantly changing. With the continuous progress of technology and the continuous expansion of application fields, some enterprises with technical advantages and market strength gradually stand out and occupy a larger market share. At the same time, some emerging enterprises are also making continuous efforts and innovation, trying to break the existing market pattern and increase their market share. The market share of the magnetic refrigeration system industry is expected to continue to grow steadily in the next few years, but the competitive landscape may change [7].

5.3 Enterprise Competitive Strategy and Advantage Analysis

In the magnetic refrigeration system industry, the competitive strategy between enterprises mainly includes technological innovation, market expansion, cost control and so on. Through continuous technological innovation, enterprises can improve the performance and quality of products to meet the needs of the market; Through market expansion, enterprises can expand sales network and improve brand influence; Through cost control, enterprises can reduce production costs and improve profitability. At the same time, the advantages of different enterprises are also different. Some enterprises have strong strength in technology research and development, and can constantly introduce new products and technologies; Some enterprises have advantages in manufacturing and sales, and can provide high-quality products and services [8].

6.Technical Progress of Magnetic Refrigeration System

6.1 Latest Technology Development Trends

In recent years, magnetic refrigeration system technology has made remarkable progress. Researchers at home and abroad have improved the performance and efficiency of magnetic refrigeration systems through continuous research and development and innovation. For example, some researchers have improved the cooling efficiency and stability of magnetic refrigeration systems by optimizing the structure and properties of magnetic materials. Some researchers improve the design and manufacturing process of magnetic chillers to improve their reliability and service life. The core technology of magnetic refrigeration system mainly includes magnetic material, magnetic refrigerator and magnetic refrigeration controller. These technologies play a vital role in the design and manufacturing process of magnetic refrigeration systems. At the same time, domestic and foreign enterprises are also actively applying for relevant patents to protect their technological achievements and intellectual property rights. These patents cover all aspects of magnetic refrigeration systems and provide strong support for the further development of the industry [9].

6.2 Discussion on Market Prospects of New Technologies

With the continuous progress of magnetic refrigeration technology and the continuous expansion of application fields, the new technology has a broad market prospect. For example, in the field of aerospace, magnetic refrigeration technology can meet the needs of refrigeration in high temperature environments, providing a strong guarantee for the normal operation of spacecraft; In the medical field, magnetic refrigeration technology can provide a stable low temperature environment for the storage of biological samples and medicines; In the field of refrigeration and air-conditioning, magnetic refrigeration technology can provide efficient and environmentally friendly refrigeration effects to meet the needs of consumers [10].

7.Conclusion

Magnetic refrigeration technology, with its high efficiency, environmental protection, low noise and long life and other significant advantages, is gradually becoming a bright star in the field of refrigeration, indicating the important development

direction of refrigeration technology in the future. In this paper, the comprehensive development status and challenges in the field of magnetic refrigeration are deeply discussed, and valuable insights are provided for the further advancement of this cutting-edge technology.

At the beginning of the article, the basic overview of magnetic refrigeration system is given, and its working principle based on magnetothermal effect is expounded, and the initial cognitive framework of magnetic refrigeration technology is constructed for readers. Then, through the detailed analysis of market supply and demand, it reveals the growing market demand and potential broad market space of magnetic refrigeration technology. At the same time, the analysis of the competitive situation of the industry further shows the competitive pattern and vitality in the field of magnetic refrigeration.

In terms of technical progress, the paper summarizes the latest research and development achievements and application examples of magnetic refrigeration technology in detail, highlighting its significant improvement in refrigeration efficiency and environmental performance. However, magnetic refrigeration technology also faces challenges such as high material cost and insufficient technical maturity. In this regard, the paper puts forward some countermeasures to overcome these problems.

Looking forward to the future, the development prospect of magnetic refrigeration technology is remarkable. With the continuous breakthrough of technology and the gradual reduction of cost, magnetic refrigeration technology is expected to be widely used in more fields, and contribute to the green transformation and sustainable development of the refrigeration industry. The research in this paper not only provides theoretical basis for further exploration in the field of magnetic refrigeration, but also provides practical guidance for related enterprises' technological innovation and market development, which has important reference value.

References

[1] Liu Guoqiang, Ke Yajiao, Zhang Kongbin, He Xiong, Luo Feng, He Bin & Sun Zhigang.(2019). Research progress of physical model of all-solid-state magnetic refrigeration system. Journal of Physics (21),7-20.

[2] Zheng Zhigang & Zeng Dechang.(2020). Research on high-efficiency magnetic refrigeration system.(eds.) Abstract Collection of 2020 Annual Conference of Chinese Society of Rare Earth and Green Development and Efficient Utilization Conference of Jiangxi (Ganzhou) Rare Earth Resources (pp.174). South China University of Technology; Doi: 10.26914 / Arthur c. nkihy. 2020.024905.

[3] Zhu Zhang.(2021). Research on Helicopter refrigeration System and Key Heat Transfer Components (Master's Thesis, Nanjing University of Aeronautics and Astronautics). Master,https://link.cnki.net/doi/10.27239/d.cnki.gnhhu.2021.001447doi:10.27239/d.cnki.gnhhu.2021.001447.

[4] Zhu Mingshan, Wang Xin.(2002). The past, present and future of refrigerants. Journal of Refrigeration (01),14-20.

[5] Shen Jun. (2022). Research progress of magnetic refrigeration technology.(eds.) 2022 Academic Annual Meeting of Chinese Society of Rare Earths, Abstract of the 14th China Baotou Rare Earth Industry Forum (pp.149). Beijing Institute of Technology; Technical Institute of Physics and Chemistry, Chinese Academy of Sciences; Ganjiang Institute of Innovation, Chinese Academy of Sciences; Doi: 10.26914 / Arthur c. nkihy. 2022.054133.

[6] Yan Hongbo, Yang Zizhong, Wang Jianxin & Hao Hongbo.(2018). Application research of magnetic refrigeration technology based on patent analysis. Science and Technology Management Research (15),199-204.

[7] Wang Keping, Guo Xiaofang & Che Yao.(2021). Research on risk identification and Competitive intelligence early warning of strategic emerging industries under the thinking of big data. Theory and practice of intelligence (05), 92-99. Doi: 10.16353 / j.carol carroll nki. 1000-7490.2021.05.014.

[8] Zhao Jie, Wen Run, Ma Zheng, Wang Xueya & Zhang Huinan.(2013). Competitive Intelligence Services for Strategic Emerging Industries: Demand Analysis and System Construction.(eds.) Proceedings of the 8th (2013) China Annual Management Conference -- Information Management Conference (pp.54-64). School of Business, Anhui University;

[9] Huang Jiaohong, Liu Cuilan. Recent progress in practical application of room temperature magnetic refrigeration technology [J]. Rare Earth Information,2015(8): 14-17.

[10] WU Dianzhen, Zheng Hongxing, Zhai Qijie. Research progress of magnetic refrigeration materials [J]. Materials Review,2011, 25(15): 9-14. (in Chinese).