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Research on Digital Upgrading and Challenges of New Energy Battery Production

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Abstract: *Digital transformation and upgrading play a very important role in improving the efficiency and quality of production and manufacturing while improving the level of new energy technology and productivity in our country. This article analyzes the planning methods, main upgrading directions, and challenges faced by the digital upgrading process of new energy battery production from the perspective of new energy battery production. It provides theoretical guidance for Chinese new energy industry to effectively respond to future market changes while avoiding problems in the development process, which has important practical significance.*

Keywords: *NEB(New energy battery); battery production; digital upgrade; upgrade challenge*

1. Introduction

In recent years, Chinese new energy vehicle industry has experienced rapid development and has shown a trend towards leading the world. The production of new energy batteries is the core technology in the new energy vehicle industry, and the precision and efficiency of its manufacturing process play an important role in reducing costs and expanding the scope of new energy applications. Due to the particularity of the production process of new energy batteries, many new energy battery manufacturers in China still maintain a high manual labor rate in the production process, resulting in relatively high production costs of new energy batteries, which has a certain impact on the popularization and development of new energy technology. In order to effectively reduce the production cost of new energy batteries, it is not only necessary to attach importance to the research and development of new energy technologies, but also to effectively upgrade existing production processes and processes. There are already a large number of industrial production application cases of digital technology in the field of industrial production, which the digital upgrade of new energy battery production can be referred to. In order to better carry out the digital upgrade of new energy battery production, effective overall planning and hierarchical planning should be carried out from the perspective of top-level design, so as to efficiently apply digital technology, reduce the production cost of new energy batteries, and provide a reliable foundation for the sustainable development of the new energy industry.

2. Analysis in Digital Upgrade Plan for New Energy Battery Production

2.1. Enterprise level overall planning

The overall planning of the enterprise layer is an important foundation to ensure the digitization and networking of the manufacturing process of new energy batteries. In the process of adapting to the digitization of product design and process design, a collaborative management platform connecting data network and industrial Internet should be constructed from the point of view of enterprise overall planning, so as to realize the effective matching of various data new energy battery production modes, and lay a good foundation for the whole process of intelligent manufacturing of new energy batteries. In this process, PLM (Product Lifecycle Management) and ERP (Enterprise Resource Planning) systems can be used as the core of enterprise digital upgrade, and resource data integration system can be used to realize visual control of production process while digitally managing enterprise production resources[1]. the ERP system should be used to effectively manage the enterprise's resource planning to ensure that human resources, procurement, production, sales and other resources can be managed comprehensively, and play its role. The enterprise resource data integration is used to realize the whole life cycle management of PLM system and production process. In the process of production and manufacturing, the MES (Manufacturing Execution System) management system should be used to

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manage the equipment, production preparation, warehouse and other resources to ensure the improvement of the visual level of production management and control, and to improve the digital level of production process with reliable automatic and intelligent management system.

2.2. Digital design of workshop layer

The digitization of the workshop layer requires the construction of a digital assembly workshop using an MES system, and the use of simulation policies and numerical control management for battery production processes to achieve effective connection between production processes and on-site production management, thereby ensuring good digital production results. In the production process of new energy batteries, the MES system can collect various data during the production process. It can also carry out digital management and control of workshop equipment and production processes while based on the requirements of production process management and quality management[2]. For example, in the case of introducing new equipment, the application of the new equipment in the production process needs to evaluate its CMK value based on the 6σ mechanisms, and determine that the equipment can effectively optimize the application of the equipment in the workshop on the basis of effectively improving the operation effect of the production line. According to the production process of new energy battery, the CPK value of the equipment applied in the production process is further calculated, so as to evaluate the impact of the introduction of new equipment on the production capacity of the workshop, so that it can further improve the production process and production plan of the workshop, and provide a reliable guarantee for the improvement of production quality and efficiency of new energy battery.

2.3. Intelligent design of executive layer

The intelligent design of the executive layer helps to ensure that the production equipment can carry out comprehensive data acquisition and management control in the process of new energy battery production. The executive layer needs to take Ethernet technology and Internet of things technology as the core, then establish a Profibus network to closely contact all the equipment of each production line in the workshop, and carry out integrated and unified management through PLM, so as to facilitate fault diagnosis and production control. Due to the particularity of new energy battery products, there are a large number of non-standardized designs in the actual market of electronic products, resulting in some of the performance of the existing production equipment may not fully meet the actual needs of digital production. However, with the development of related technologies and the accumulation of data, the effective management of equipment failure, equipment control, and preventive management and maintenance can be carried out more accurately. Thus, in the process of equipment maintenance and operation, it can effectively improve the operation efficiency of the equipment, reduce the loss of equipment caused by overload and non-standardized production, and improve the reliability of the digital production line in an all-round way[3].

3. The direction of digital upgrading of new energy battery production

3.1. Digitization of product design and process

The digitization of product design and process is an important measure to improve the production efficiency, digital level and reduce the cost of new energy battery. it can lay a good foundation for improving the stability of product quality. In the design process of new energy battery products, the simulation technology based on MES can use virtual prototyping and simulation testing to effectively speed up the product development cycle. At the same time, computer aided design software can be further used to optimize the design of new energy battery products in the virtual environment. Testing the product performance through the simulation software and analyzing the possible problems in the design scheme can effectively reduce the unreasonable content of the product design and correct the relevant errors in time, so as to improve the reliability of the new energy battery. In the process of production, the MES system can be used to transform the design drawings into digital process models, so that the workshop can quickly implement the process requirements in the design drawings, so as to ensure that the production of the products can meet the standards of the original design, and make sure that the digital workshop can accurately execute production orders. In addition, in the production stage, the massive production data collected by digital sensors can also be used to monitor and control the running state of the equipment, predict and find faults in time meanwhile provide reliable data support

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for the optimization of production process and improve the efficiency and quality of production.

3.2. Digitization of product production management

In the process of digital production, the interface between the production workshop and the execution layer can ensure the integration and digital management of production systems such as ERP and MES by the ESB(Enterprise Service Bus), thereby ensuring the unified management of business flow in each link of new energy battery production, ensuring collaboration between various business systems, and reducing system delays caused by data format conversion and other reasons. In the process of digital upgrading, integrated management between various systems can ensure timely sharing of information in the production of new energy batteries, thereby avoiding resource waste caused by information lag. And while improving the efficiency of material and equipment utilization, the production line can be adjusted according to the production demand and market demand of new energy batteries, improving the delivery capacity of the production line[4]. For example, under the premise of analyzing order and equipment conditions based on real-time production data, the scheduling system of digital production can carry out intelligent scheduling, combine the allocation and use of production resources to greatly improve the accuracy of scheduling plans and maximize the efficiency of product production management.

3.3. Digitization of production supply chain processes

The production and supply chain of new energy batteries includes multiple processing links, and many raw materials in these links contain toxicity, which can have an impact on the health of production personnel. At the same time, in the process of realizing digital assembly line in the production and assembly of new energy, good logistics technology must be adopted to ensure the efficiency and quality of battery production and assembly. For example, in terms of workstation conveying, using roller conveying methods, the operation of the system must be adjusted according to the needs of different workstations during the material conveying process. Although standardization of material transportation can be ensured by increasing the number of industrial robots, it is still necessary to digitize the production supply chain process to ensure the reliability of the system. For example, in the process of using ERP and WMS systems for production supply chain management, it is necessary to ensure effective connection between warehousing, production lines, semi-finished product warehouses, finished product warehouses, and other links. Only by establishing automated warehouse operations and industrial robot operations can the full implementation of the production supply chain process be ensured.

4. The challenges faced by digital upgrading of NEB production

4.1. Digital traceability of production processes

According to data statistics on the production of new energy batteries, there are at least 3200 key control points in the entire process of production and assembly of new energy batteries in the actual production process. Due to the complexity of production processes and procedures, new energy batteries must ensure comprehensive collection and processing of various data during the digital upgrade process. The agility requirements for the production and assembly of new energy batteries are high. In the case of fast data generation speed and high real-time data requirements, in order to ensure the consistency and reliability of product quality, it is necessary to do a good job in data traceability and management to comprehensively ensure the accuracy and reliability of data, laying a good foundation for the control and management of the production and assembly quality of new energy batteries[5].

In a large new energy battery production base, the amount of data generated each month is over 3 billion. Both data collection and data entry face various processing pressures. The status of production equipment and production parameters are key and core data for the digitization of new energy battery production. The generation of these large amounts of high-value data means that their processing places higher demands on the transmission and storage of data. In the process of ensuring the effectiveness of data processing, it is not only necessary to improve the bandwidth and storage capacity of data transmission, but also to fully consider the various impacts of data security and privacy on the production of new energy batteries. Therefore, in ensuring the efficient integration and utilization of relevant data, it is necessary to establish a comprehensive digital traceability mechanism, which has

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become the biggest challenge facing the digitization of new energy battery production.

In addition, at present, the bad PBB in the production and assembly of new energy batteries usually needs to be reduced to less than one billionth. It is not difficult to see that the quality control requirements for the production of new energy batteries are high, and a large number of key control points and massive data generation also pose great challenges to the quality control of digital production of new energy batteries. In order to ensure comprehensive control over the production process, while ensuring data collection and processing, it is also necessary to promptly identify problems that exist in the production process and take timely measures to handle them, thereby bringing higher data accuracy and integrity requirements[6].

4.2. Integration and collaborative application of digital technology

From the perspective of digital technology applications alone, digital technology covers a wide range of fields, including image recognition, artificial intelligence, and predictive algorithms. However, these technologies are usually integrated and applied to solve tasks and requirements in a certain stage of the production process. Therefore, the application of digital technology also needs to consider issues such as interoperability and compatibility of different solutions. Especially in the production process of new energy batteries, there are many links of cooperation and collaboration between different enterprises. In the process of carrying out cross enterprise and cross base collaborative operations, how to solve the inconsistency of enterprise digital technology, systems, and data standards is also a problem that must be considered in the digital upgrading of new energy battery production. Due to the differences in enterprise and production base platforms, when implementing system integration and data integration, it is necessary to consider the smoothness and accessibility of information flow, and effectively improve the integration and collaborative application level of digital technology through unified data standards and formats.

In addition, from the perspective of the global supply chain, the production and assembly process of new energy batteries in China has not fully achieved self ownership of production resources such as technology, raw materials, and equipment, resulting in the production of new energy batteries relying on the complex international supply chain network. However, the laws, regulations, and commercial regulations of different countries are not the same. In the process of compliance and risk management, how to achieve global supply chain integration and collaboration has become one of the main factors affecting the digitization of new energy battery production. Especially in the process of cross-border coordination, due to the different positions and priorities of different production materials in the new energy battery production supply chain, it is necessary to overcome delays in communication, decision-making, and other aspects in order to achieve the goal of digital upgrading of new energy battery production while ensuring the synergistic effect of the production process[7].

4.3. Obstacles in the production supply chain process

At present, there is a lack of widely recognized production standards for new energy batteries in the international new energy battery market. The foundation and ultimate goal of digital upgrading is to achieve standardized production of new energy batteries, in order to improve production efficiency and quality. However, in the absence of unified standards, there will be various obstacles in each link of the production supply chain, and the implementation of digital upgrading will face numerous difficulties.

Firstly, in terms of equipment, the automation production capabilities of battery production equipment provided in the current new energy market are uneven. At the same time, the development and manufacturing of production equipment are in the early stages of exploration and development, resulting in significant differences in data standards and formats used between different devices, leading to information silos and the inability to guarantee comprehensive support for digital upgrades. Secondly, in the current process of production data collection, due to the inconsistency of data collection equipment and data analysis models, the accuracy and timeliness of production process data cannot meet the comprehensive support for digital production. Meanwhile, in the process of analyzing the value of production data, the quality of the analysis results cannot be effectively guaranteed, resulting in unreliable and incomplete data, making it difficult to provide high-quality data support for digital upgrading and making good decisions and optimization suggestions for digital production. Thirdly, in the process of product data traceability, due to the different data standards of different equipment, it is difficult to perform cross process traceability throughout the entire process of data traceability. The large amount of data generated during the production process, as well as the high cost

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of data storage and processing, poses a great obstacle to the digital upgrading of new energy battery production. Finally, in the application process of big data and intelligent data analysis technology, due to the huge amount of control data generated by single piece flow products, especially in the mass production process, there are often billions of data levels. Under the requirement of second level data response in the production of new energy batteries, it is difficult to ensure the application effect of relevant technologies, which poses significant challenges to the digital upgrading of new energy battery production.

5. Conclusion

In summary, the digital upgrading of China's new energy battery production is an important prerequisite for improving the efficiency and quality of new energy battery production, and ensuring the development of China's new energy industry. At present, the theoretical direction for digital upgrading of new energy battery production has been established. However, due to the particularity of new energy battery production, it still faces multiple challenges in practice, which brings various impacts on digital upgrading. In the process of in-depth exploration and thinking, it is necessary to fully combine the characteristics of new energy battery production, continuously adjust and innovate based on the existing theoretical framework and the challenges faced in practice, in order to solve the most critical energy storage problem in the development of China's new energy industry, and lay a good industrial foundation for the realization of China's carbon neutrality and sustainable development strategy.

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