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Research on Storage Management of Hazardous Chemicals based on Internet of Things

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The storage of hazardous chemicals is an important link in the supply chain. Improper storage of hazardous chemicals can cause great security risks. The occurrence of hazardous chemicals accident not only causes economic losses, but also destroys environment. Much of this is due to the lack of effective means of storing hazardous chemicals. With the continuous development of modern science and technology, many new technologies have been used, such as RFID technology in the Internet of Things. However, many enterprises are still in the traditional stage in the storage of hazardous chemicals. If RFID technology is combined with the storage of hazardous chemicals, it is an effective way to improve management efficiency, reduce operation cost and enhance safety level. In this paper, we use RFID technology to establish the storage management system and traceability system of hazardous chemicals based on Internet of Things. Through the establishment of these two systems, it can effectively save costs, reduce security risks, improve safety levels and increase consumer confidence.

1. Introduction

The production and usage of chemicals are increasing. At the same time, some hazardous chemicals are flammable, explosive and radioactive. They may lead to the accidents during production, transportation, storage and other processes. Hazardous chemicals have serious consequences, which can cause great harm to life, property and environment. With the development of science and technology, it has become a major trend to promote the healthy development of hazardous chemicals industry by means of information technology and advanced technology to improve the life cycle supervision of hazardous chemicals. As the one of ten key technologies in twenty-first Century (Sun and Dong, 2011), radio frequency identification technology (RFID) has gradually been widely used in coal mine management (Xu, 2009), security (Pei, 2008), the food industry (Bai, 2013), logistics and supply chain (Zuo et al., 2010) etc.

In the field of hazardous chemicals management, the emerging RFID technology has just started. Therefore, there are still many problems. In production, storage and transportation management of the hazardous chemical in application, this technology can improve the efficiency of the management of hazardous chemicals, make the supply chain management more scientific and solve the problem of blind spots in management of hazardous chemicals logistics to guarantee the quality and safety of hazardous chemicals. Scholars have established cargo space management, warehousing operations, cycle storage and quality traceability system etc. They were very optimistic about the application of RFID technology in the management of hazardous chemicals (Yang, 2008). Some scholars have introduced the application of RFID system in the transportation of hazardous chemicals, safety management, warehousing and delivery. At the same time, they analysed problems with the use of the RFID system in the hazardous chemicals industry. The scholar believed that there were three main types of problems. They were the standard problem, the security problem and the cost problem (Han et al., 2010). Through the study, we find that the management of hazardous chemicals using modern science and technology is less. The research of RFID technology in the storage management of hazardous chemicals is also scarce. It will greatly reduce costs, increase industrial competitiveness and improve the safety level of hazardous chemicals storage if RFID technology is applied to the storage management of hazardous chemicals. Under this background, we apply RFID technology to the storage management of hazardous chemicals. It is necessary to establish a storage management and

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traceability system for hazardous chemicals based on RFID technology. The structure of this paper is as follows. The first part is the introduction. In this part, we introduce the research background. The second part is the RFID technology and we mainly introduce the RFID technology. The third part analyses the necessity of establishing the storage management system of hazardous chemicals based on RFID. In this section, we study the necessity of establishing a storage management system and traceability system for hazardous chemicals based on RFID. The fourth part is the storage management system of hazardous chemicals based on RFID. In this section, we study the storage management system and traceability system of hazardous chemicals based on RFID. Then we introduce the warehousing operation process, the stocktaking operation process, the delivery operation process and the traceability system respectively. The fifth part is the conclusion.

2. RFID technology

RFID is short for Radio Frequency Identification. In 1984, Harry Stockman published “Communication by Means of Reflected Power” in the Institute of Radio Engineers. It built the foundations theoretical foundations of RFID (Soonuk et al., 2017). In recent years, with the rapid development of chip technology, computer and wireless network technology and application, electronic label costs continue to reduce and the scale of industrial application is constantly expanding. The theory and application of radio frequency identification technology have been further enriched and improved (Jacob and Thiemann, 2017).

In RFID technology, the reader transmits a certain frequency of radio frequency signals via a transmitting antenna. When an electronic tag passes through a specific area, an induced current is obtained (Yunsik et al., 2017). After the tag gets the induced current, it sends some of its information through the built-in antenna. The system receives the information and passes it through the antenna adjuster to the reader. The reader adjusts and decodes the information emitted by the tag, and then sends it through the host to the management system in the background. The management system processes and controls the information and issues an instruction signal to control the reader to perform different operations (Tu, 2017). The working principle is shown in the following figure.

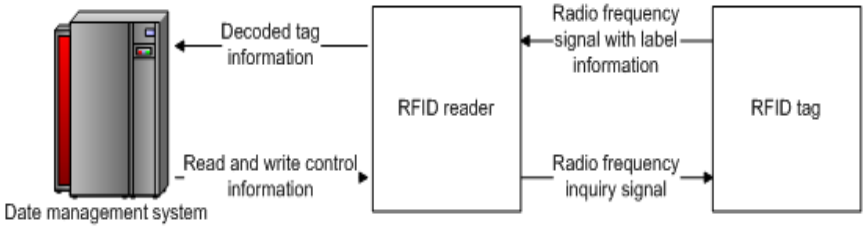

Figure 1: Work principle of RFID

3. The necessity of establishing storage management system of hazardous chemicals based on RFID

With the popularization of RDFI technology, chemical enterprise is accepting RFID new technology. The whole enterprise can realize automation, reduce the error rate and improve the safety level. At the same time, it can also improve the service quality of chemical enterprises, reduce costs, improve efficiency and enhance the corporate image. The advantages of RFID technology will be of great help to the chemical industry. It will enhance the competitiveness of enterprises. Therefore, the establishment of RFID based storage management system for hazardous chemicals has the following meanings.

(1). The clear responsibilities. Hazardous chemicals are prone to accidents. In the process of transportation and storage of hazardous chemicals, unsafe factors are often caused by human factors. It can effectively identify the clear responsibility of hazardous chemical accidents, reduce unnecessary losses by using the established storage management system with RFID technology and traceability system of hazardous chemicals.

(2). Reduce the operating costs of the chemical supply chain. Inventory cost is the largest part of supply chain cost. Effective chemicals storage management systems can not only reduce human error, but also improve inventory efficiency. It greatly reduces the operating costs of chemical supply chain.

(3). Boost consumer confidence. The application of RFID technology can increase consumer confidence. Consumers can learn the details of all aspects of the chemical industry. RFID can not only transfer detailed information to consumers, but also promote the safety awareness of chemical enterprises in turn. At the same

time, consumers can learn the information of chemical products and supervise the chemical enterprises. This greatly enhances consumer confidence in chemical safety.
(4). Enhance competitiveness. It can improve the competitiveness of enterprises by using RFID technology to establish chemical supply chain, storage system and traceability system

4. Research on storage management system of hazardous chemicals based on RFID

RFID technology is the carrier of hazardous chemicals storage management. RFID will replace the traditional barcode technology in the storage of hazardous chemicals. Bar code is represented by a simple number. It has no storage space. A large amount of data information can only be stored in the background management. This feature requires a high level of information processing capacity of the background and the requirements for the size of the database. If RFID technology is applied, information on each item will be written on pallets or container tags. When the reader passes these trays or containers, the relevant information can be read immediately. RFID technology simplifies workflow by not having access to the database. Hazardous chemicals storage management system framework is as shown below.

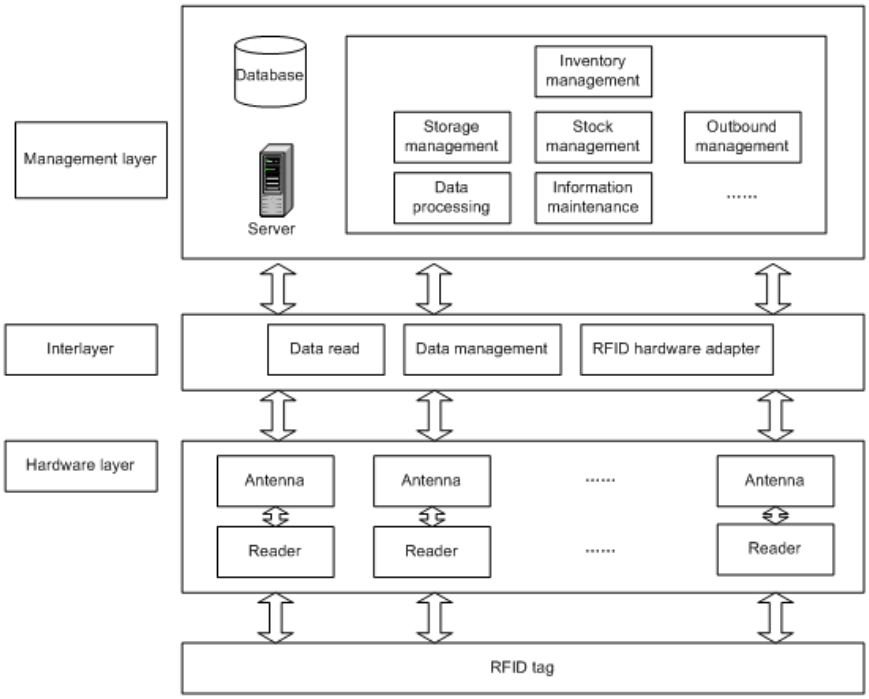

Figure 2: Framework of hazardous chemicals storage management system based on RFID

4.1 Warehousing operation

Warehousing operation process is as follows. When the hazardous chemicals arrive at the warehousing operation, the RFID reader reads the relevant information about the hazardous chemicals and compares them with the delivery information provided by the manufacturer's database server. If the product is qualified, then it is allowed to be warehoused; if not qualified, it will be returned. At the same time, the warehousing management system will distribute the warehoused hazardous chemicals into the library. The delivery time, delivery personnel, location and handling equipment are arranged in advance. After arriving at the designated warehousing, the goods fitted with electronic tags will be handled. The reader automatically inputs the relevant information of hazardous chemicals into the warehousing management system and completes the warehoused hazardous chemicals. Then, RFID reader obtains shelf label information and compares it with hazardous chemicals to confirm of hazardous chemicals to the designated location. Finally, the information system updates the stock information automatically.
The hazardous chemicals warehousing management system based on RFID can arrange work more reasonably and save time. At the same time, the system can update the information in time to ensure the hazardous chemicals be warehoused timely and to eliminate the hidden dangers of warehousing.

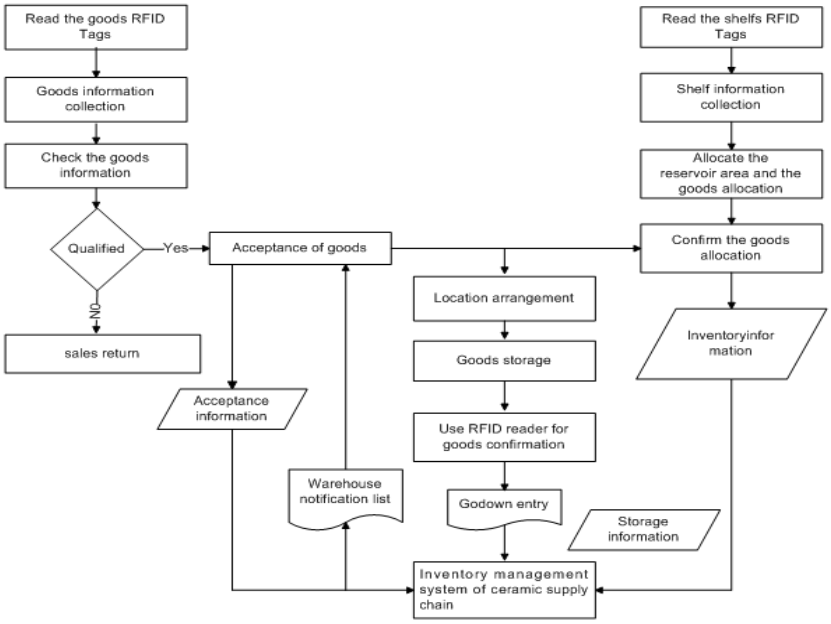

Figure 3: Framework of hazardous chemicals warehousing management system based on RFID

4.2 Stocktaking operation

After accepting the instruction of stocktaking, the storage personnel will use the reader to scan the hazardous chemicals labeled with electronic tags to obtain the commodity information. The storage personnel will store the information in the operation log and send the operation log to the background management system. Because RFID has the characteristics of multi data read, it can know the number of hazardous chemicals, clear space and a series of information in each data acquisition. These measures will greatly save time and manpower. Storage management system automatically scans the information, checking storages information and analyzes safety stocks.

When the difference between the quantity of the product and the storage information is found, the storage management system can retrieve the goods details and make a quick check to find out the error point. According to this information, relevant personnel will deal with in a timely manner to eliminate security risks.

The flow chart of the stocktaking operation of hazardous chemicals is shown below.

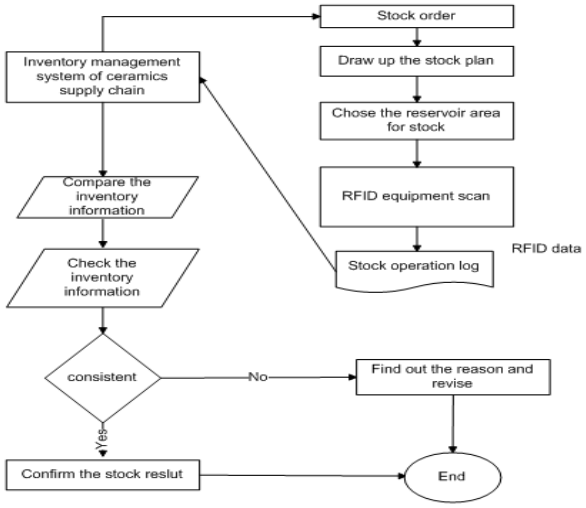

Figure 4: Framework of hazardous chemicals stocktaking management system based on RFID

The stocktaking operation of hazardous chemicals storage management system based on RFID can save a great deal of time and reduce human error. More importantly, RFID based on inventory can reduce operating

environment, improve the accuracy of judgment, eliminate potential safety problems and reduce the possibility of hazardous chemicals accidents.

4.3 Delivery operation

In the traditional storage management, delivery is the most vulnerable part. The delivery of the product requires verification of the shipment order. Errors arising from delivery and errors during sorting can not only bring higher recall rate to enterprises, but also affect the reputation of enterprises and improve the possibility of hazardous chemicals accidents. In the process of carrying out the shipment, the storage management system will determine the optimal way of delivery according to the order requirements. When the hazardous chemicals are shipped out, the mobile device or the fixed reader is used to transfer the operation result to the storage management system through wireless network. When hazardous chemicals are sent to the automatic sorting device, the reader on the automatic sorting device reads the labels during the movement of the goods and identifies which user the item belongs to. Order items are shipped to the storage port and the staff scans the goods with a mobile device.

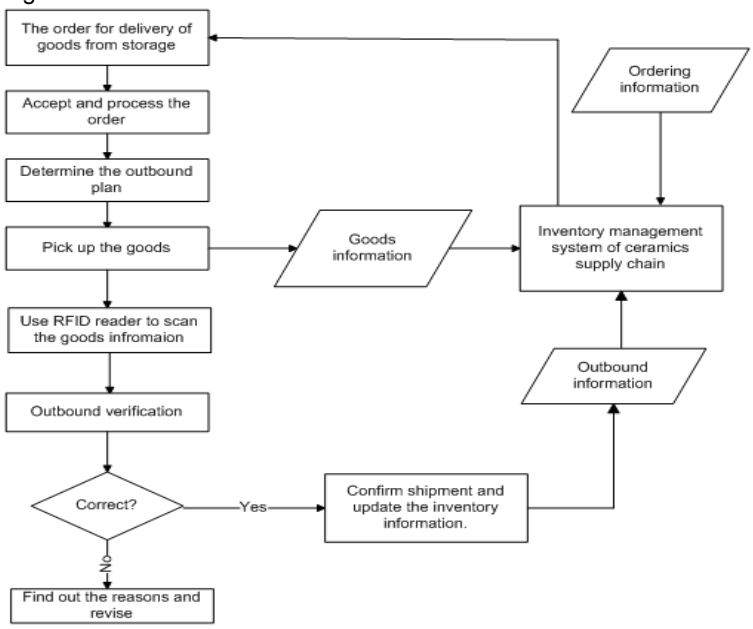

Figure 5: Framework of hazardous chemicals delivery management system based on RFID

RFID based on delivery process of hazardous chemicals storage management system can avoid manual writing and reduce the error rate. It can also improve the speed and accuracy of goods sorting. In addition, the use of handheld RFID reader to check out the goods and the final confirmation of the delivery is conducive to timely updating of the storage, reduce the probability of the error out of the library and improve the safety factor of hazardous chemicals.

4.4 Research on traceability system of hazardous chemicals based on RFID

After researching the storage system of hazardous chemicals based on RFID, we establish the traceability system for the hazardous chemicals supply chain based on RFID. Generally speaking, the traceability system has three functions. The first is to recall and process the products that have hidden dangers. The second is that it can investigate the possible problems of the link in order to find out the reasons and responsible persons. The third is the business process optimization and supply chain integration management. Therefore, it is necessary to establish a RFID based traceability system for hazardous chemicals.

In the traceability system, producers, retailers and consumers can find relevant information about hazardous chemicals. Manufacturers and retailers send data information to the related databases. Users can access the traceability system through the user interface.

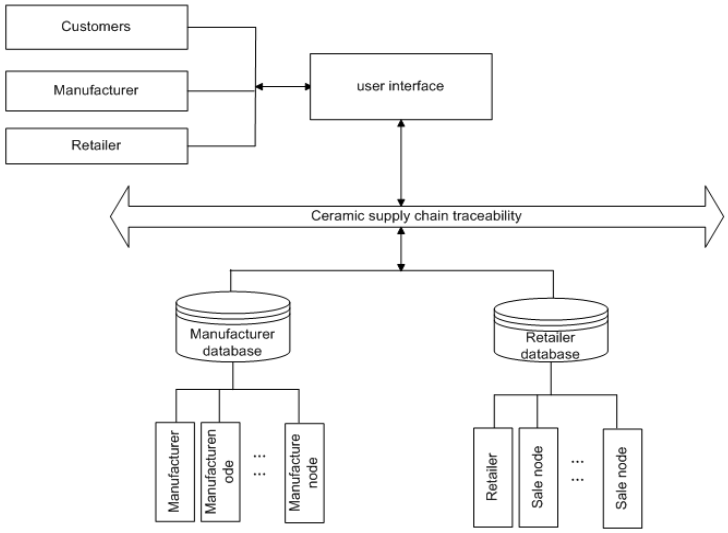

Figure 6: Framework of hazardous chemicals traceability system based on RFID

5. Conclusions

China is a big country in the production and use of chemicals. At the same time, China's chemical storage management is still in the stage of traditional management. RFID technology is an important technology in the emerging Internet of things. In RFID technology has matured today, many industries have used RFID technology. The combination of RFID technology and the storage management of hazardous chemicals can reduce the probability of accidents, reduce costs, improve service quality, and enhance consumer confidence etc. At the same time, RFID technology will also enhance the competitiveness of enterprises.

The main work of this paper is as follows. Firstly, we introduce the research background. Secondly, we introduce RFID technology. Thirdly, we analyze the necessity of establishment of hazardous chemicals storage management system based on RFID and traceability system. Then, we establish the storage management system and traceability system of hazardous chemicals based on RFID. Finally, we introduce the warehousing operation process, the stocktaking operation process, the delivery operation process and the traceability system.

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