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Research Article

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Study on monitor system of pollution discharge in chemical enterprise based on internet of things

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ABSTRACT

Pollution discharge management is important for the sustainable development of the chemical enterprise, and the monitor system of pollution discharge is an important part for improving the pollution discharge management of the chemical enterprise, therefore the application of the Internet of things on it is studied in depth. Firstly, the main technology problems of the monitoring system of pollution discharge in chemical enterprise are summarized. Secondly, the relating technologies of the Internet of things are studied. Thirdly, the monitoring system based on Internet of things of the pollution discharge in chemical enterprise is designed. Finally, simulation analysis is carried out, and the effectiveness of the monitoring system is verified.

Key words: Monitoring system; pollution discharge; chemical enterprise; Internet of things

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The pollution discharge pipes are main infrastructures of the chemical enterprise, which are important for developing the economics of the chemical enterprise. The monitor system of the pollution discharge is an import part of the chemical enterprise, and it can monitor the indexes of whole procession concluding sample collection, procession, analysis and data transmission based on automatic control technology, Modern analysis method and means of communication and computer software technology. The monitoring system concludes two parts, which are environment quality monitoring sub system and pollution source monitoring sub system. The former sub system can offer the correct and timely environment quality data for the chemical enterprise. The latter sub system can track the situation of pollution discharge of the chemical enterprise. The monitoring system of pollution discharge has some advantages, such as multi points, wide range and large amount. In order to satisfy the requirement of the requirement of the monitoring system of pollution discharge in chemical enterprise, an effective technology should be applied in it. With the development of science and technology, the Internet of things has become an important technology for developing the socioeconomic. The Internet of things has been applied in many fields. For the chemical enterprise, the advanced sensor technology, data fusion technology and internet technology can be combined to construct the monitoring system of pollution discharge, and then the sustainable development of the chemical enterprise can be ensured [1].

Main technology problems of the monitoring system of pollution discharge in chemical enterprise

According to the real situation of the chemical enterprise, the monitoring system is designed based on Internet of things, which has high reliability, and complete function. The main technology problems are listed as follows:

(1) An advanced monitoring system of pollution discharge of chemical enterprise is constructed based on Internet of things, and the system is suit for the actual requirement of pollution management of chemical enterprise. The monitoring system concludes management level, controlling level, monitoring level and field level, it can complete the data exchanges, and the pollution data inspection, and can offer the human-computer interface, which can be easy to use [2].

(2) The monitoring system can offer the remote connection function, which strengthen the data transceiver and processing abilities. The monitoring system can achieve the wired and wireless network connections. According to

the pollution discharge of chemical enterprise, the distributing network system consisting of wireless network is applied.
(3) The monitoring system applies the open structure, which uses standard, modular and series design method. The monitoring system has flexible configuration, convenient application, and quick maintenance. The openness of the monitoring can be easy to extend, which can offer convenience and save cost for the chemical enterprise.
(4) The monitoring system has high safety and reliability, it can ensure the reliable operation of the system, and support the network, I/O module, operation station, controlling station. The data recorder uses hot standby redundancy, data can recover automatically after the fault, which can offer the reference data for saving energy and reducing consumption of the chemical enterprise.

Relating technologies of the Internet of things
The Internet of things refers to the ubiquitous end equipments concluding the intelligent sensors and mobile devices integrated based on wired, wireless or short-distance communication network, it can applied SaaS operation model based on cloud computing. Internet of things can offer safe and manageable online management and service functions such as monitoring, positioning and tracking, alarm linkage and dispatching and command, remote controlling, managing desktop under intranet, extra-net and internet. The Internet of things can achieve the management, controlling and operation together. The pollution discharge of chemical enterprise is very dangerous, which is suit for the Internet of things [3].

The Internet of things concludes three critical technologies, which are radio frequency identification technology, wireless sensor network, and machine-to-machine technology.

(1) Radio frequency identification technology
RFID (Radio frequency identification) technology belongs to a kind of intelligent identification technology, which applies non contact technology. The radio frequency identification signal can be used to identify the object automatically, and can collect the relating data information. RFID can use as the electronic label, which can be stuck on the body, and has many advantages. For example, the reading distance of data is long, the penetration level is high, the wear and tear is absent, the contact does not exist, the anti-pollution capacity is good, the efficiency is high and there is a large amount of data information read. At present, the pollution discharge in chemical enterprise need to use RFID technology, and the whole procession can control and operate the controlling computer of relating equipments, the RFID technology can be used to measure the relating parameters of pollution discharge in chemical enterprise, the information management of pollution discharge in chemical enterprise can be achieved, the working efficiency of the chemical enterprise can be improved accordingly.

(2) Sensor network and detection technology
Sensor is a “sensory organs” of the machine that apperceives the material world, which can perceive the signals such as thermal, force, light, electronic, sound, and displacement, it can offer the original information for processing, transmitting, analyzing and retroacting the network system. With the constant development of science and technology, the traditional sensor has developed toward the miniaturization, intelligent, computerized, network, and it can achieve the system of traditional sensor-intelligent sensor-embedded Web sensor. At present, the sensor network technology facing the Internet of things concludes advanced test technology, networked measurement and control, Intelligent sensor network node, sensor network structure and underlying protocol, detection and control of sensor network and sensor network safety and so on.

In modern chemical industry, sensor technology has wide application, for example, toxic or harmful gases are the main pollution of chemical enterprise, in order to ensure the safety of the chemical enterprise, the toxic or harmful gases should be monitored timely, and the gas sensor is an important tool for monitoring the toxic or harmful gases. The sample method of gas is simple diffusion method, which applies spreading characteristics of gas naturally, the object gas passes through the sensor in the probe, and then a signal that is proportional to the volume fraction of the gas generates. The gas pollution situation of the chemical enterprise can be obtained timely [4].

(3) Intelligent technology
The function of the intelligent technologies are different methods and technologies that can achieve certain objective smoothly, which can be applied in the embedded in the intelligent system, then intelligent level of the object can be ensured, the communication with clients can be achieved, it is an important part of the Internet of things.

The modern chemical enterprise in China is developing, however there still are some disadvantages, for example, the capital investment in pollution management is little, the advanced monitoring equipment of pollution discharge is fairly inadequate, and the intelligent level of pollution monitoring devices is relative low. In order to accommodate the real sustainable development requirement of modern chemical enterprise, the following two

aspects should be concerned, firstly, the intelligent monitoring technology should be developed actively, and the management level of pollution discharge of the chemical enterprise can be improved, and there are some relating technologies, gas and liquid pollution discharge real time monitoring system, working environment controlling and decision system of chemical enterprise, different kinds of sensors, computer chip and mechatronic systems. Secondly, the intelligent monitoring and managing system should be developed, and the management level of all kinds of pollutants in the chemical enterprise can be improved, the relating technologies conclude centered controlling computer, series of sensor, communication network, field controller and automatic executor and so on. The working environment of the chemical enterprise can be regulated through wireless management method, and the working environment of the chemical enterprise can be in the best condition, then the chemical pollutants can be processed effectively and timely, the economic and social benefits of the chemical enterprise can be ensured [5].

(4) IP v6 address technology

The development of the Internet of things is closely linked to IP v6 technology, because objective of every Internet of things connection also need the IP address using as the identification code, but the current IP v4 technology can not suit for the real requirement of the chemical enterprise development. IP v6 technology can possess big address space, which can suit for the real requirement of the node identification completely. In addition, IP v6 technology applies stateless address assignment strategy to process the address assignment situation with high efficiency. After the stateless address assignment is applied, the network can not store the address statues of nodes. Maintaining the update period of the address can simplify the procession of address assignment. IP v6 technology has some characteristics suiting for the large application of the Internet of things, and it can adapt the requirement of the Internet of things on the node in node mobility, node redundancy, service quality of network, it is a basic network technology of the Internet of things application in a certain degree.

Monitoring system based on Internet of things of the pollution discharge in chemical enterprise

Monitoring system based on the Internet of things of pollution discharge in chemical enterprise uses TCP/IP as the basis, which can achieve the information exchanges between the monitoring platform of pollution discharge in chemical enterprise and the discharge pollutants of every workshop, which can offer the data information for the monitoring platform of pollution discharge, and manage the communication interface of different protocol of pollution discharge monitoring platform, and the communication platform based on the Internet of things for monitoring the pollution discharge is shown in table 1.

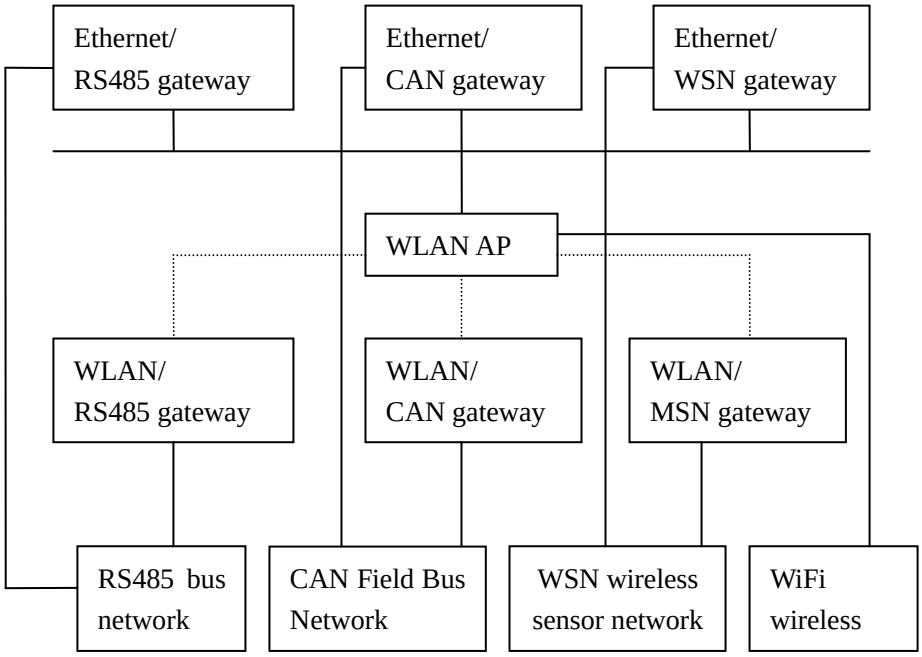

Figure 1 Status monitoring system diagram of pollution discharge of chemical enterprise

The monitoring system based on the Internet of things of pollution discharge in chemical enterprise concludes the following parts:

(a) Physical layer：the relationship between the devices and media is defined, such as the voltage, cable and pin, it can process the collision problem formed during the procession of information transformation, and it can control the

transmission flow of data.

(b) Link layer：this layer can manage the bit stream data of the bottom layer, can achieve the data transmission. The functions of this layer are listed as follows: error control, link management, and flow control. The link layer concludes two independent parts, which are medium access control system and logical link control system [6].

(c) Network layer：this layer can achieve the communication between the source node and end node of the Internet of things, it uses the IP and RIP protocols, the main functions of it concludes packaging data route data and addressing data. This layer also concludes ICMP protocol, which can achieve the diagnosis of the network.

(d) Transport layer：this layer can achieve the data transmission from end to other end, the main functions conclude the following aspects: multiple concurrent data, error correction, virtual circuit control and so on. This layer mainly concludes TCP and UDP transmission protocols.

(e) Application layer：this layer locates between the monitoring platform and communication system, there are two functions, one hand, this layer can transfer the functions of different communication protocols and devices as the interfaces and set as the service set. On the other hand, this layer can offer the search, identification and use of communication service [7].

The hierarchical structure of monitoring system of pollution discharge in chemical enterprise based on the Internet of things is shown in figure 2.

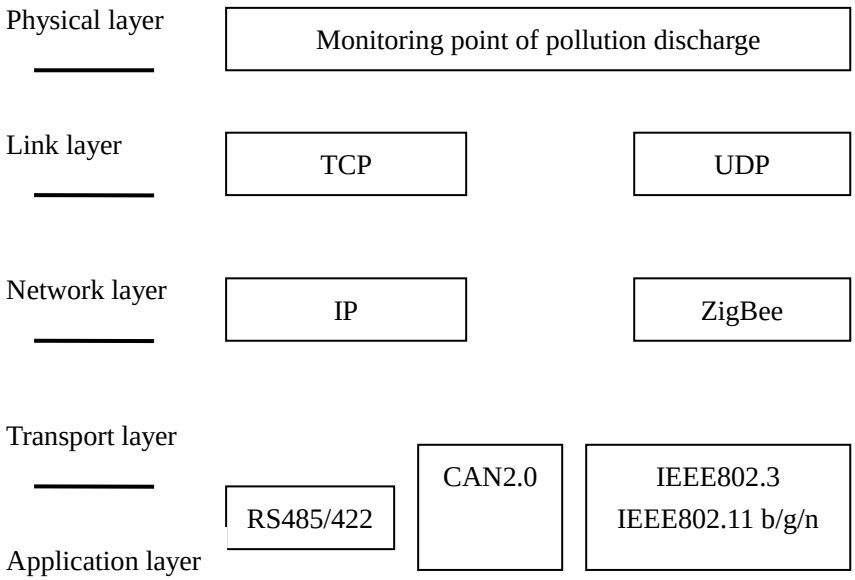

Figure 2 Hierarchical structure of monitoring system of pollution discharge in chemical enterprise based on the Internet of things

Location algorithm

There are many clusters that can measure the emissions of different pollutes in chemical enterprise. For different clusters, the data transmission of cluster head and sensor nodes can be achieved through one time jump, however, the time accepting data for cluster head node is long, and therefore an amount of energy should be consumed. If the cluster nodes failures, the monitoring data can not be transferred, the mobile Agent node can solve this problem, at the same time, the better algorithm should be applied to confirm the optimal route, which is the location algorithm of senor. In order to improve the location precision of node, and reduce the location error of node, the DV-hop algorithm is applied in this research, and the corresponding algorithm procedure is listed as follows:

Step 1: Confirm the times of jump for the node

The monitoring data of cluster head or Agent node in the pollution discharge of monitoring system based on Internet of things is defined by (id, x, y, hop), where id denotes the order number of the Agent node, x, y denote horizontal and vertical coordination of location for the cluster head and Agent node, hop denotes the number of the jump. If the node accept the data in the first time, the data can be saved, at the same time the number of jump increases 1, if the node accept the data package transferred by the same cluster head or Agent node, the comparison is carried out between the current times of jump and existing times of jump, when the current times of jump is less

than existing times of jump, the current data can be used to replace the original data, if the whole cluster or Agent node do not change, this step is over.

Step 2: Solving the average times of jump

The average jumping distance between the i th cluster heads or Agent and other $N-1$ clusters or Agent nodes can be calculated by the following expression [8]:

$$hopV_i = \frac{\sum_{j=1}^{N-1} d(a_i, a_j)}{\sum_{j=1}^{N-1} hop_{ij}} \tag{1}$$

where, $hopV_i$ denotes the average value of every jumping distance, $d(a_i, a_j)$ denotes the distance between i th cluster head or Agent node and the j th cluster or Agent node, $\sum_{j=1}^{N-1} hop_{ij}$ denotes sum of jumping times between i th cluster or Agent node and j th cluster or Agent node.

After the average jumping distance of all clusters or Agent nodes is obtained, the monitoring data can be transferred in the Internet of things, then the first data accepted by different node can be saved.

Step 3: Location model of node

The multilateral localization method can be used to evaluate the coordinate of node, the coordinate of the node needed to be located is defined by (a_x, a_y), the coordinates of cluster heads or Agent nodes can be defined by (a_{1x}, a_{1y}), (a_{2x}, a_{2y}), ..., (a_{nx}, a_{ny}), then the coordination of the node needed to be located can be calculated by the following expressions:

$$\begin{cases} \sqrt{(a_x - a_{1x})^2 + (a_y - a_{1y})^2} = d_1 \\ \sqrt{(a_x - a_{2x})^2 + (a_y - a_{2y})^2} = d_2 \\ \cdots \\ \sqrt{(a_x - a_{nx})^2 + (a_y - a_{ny})^2} = d_n \end{cases} \tag{2}$$

The error in x and y direction of node needed to be located (a_x, a_y) is defined by (e_x, e_y), and the following expression is obtained:

$$f(a_x, a_y) = \sqrt{(a_x - a_{nx})^2 + (a_y - a_{ny})^2} \tag{3}$$

Taylor series is applied in iterative computation, the error (e_x, e_y) can be calculated in (a_x, a_y) based on Taylor expansion of the expression (3), circulation calculations are carried out, and the optimal coordinate (a_x, a_y) can be obtained finally.

RESULTS AND DISCUSSION

The coordinate of locating objective can be calculated based on the location of the weighted value and node, then the pollution discharge information needed of the chemical enterprise can be obtained, which can offer the benefit basis for the pollution management of the chemical enterprise

In order to verify the effectiveness of the monitoring system of pollution discharge in chemical enterprise based on the Internet of things, the corresponding analysis is carried out. The simulation programmer is compiled by

MATLAB software. At the same time the traditional location algorithm is also applied in the same model. A rectangular region is selected randomly, and 120 times random tests are carried out, and the simulation results are shown in figure 3.

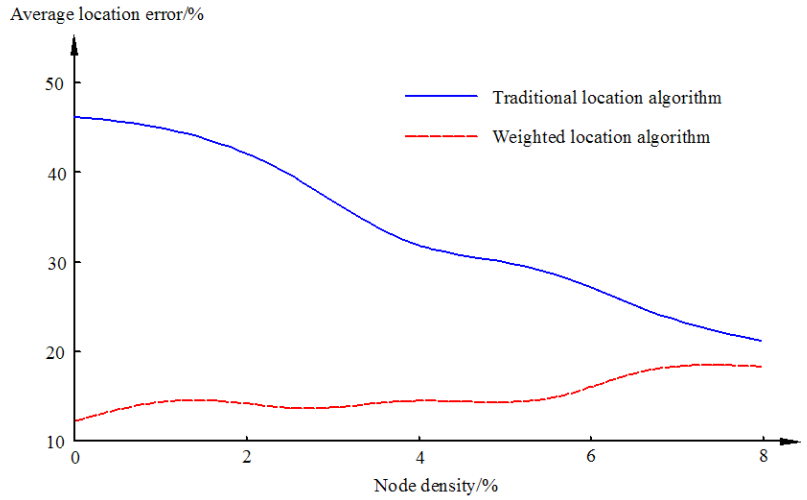

Figure 3 Comparing curves of simulation

As seen from figure 3, the average location error obtained from weighted location algorithm is less than that obtained from the traditional location algorithm when the node density is less than 8%. With the increasing of the node density, the average location error obtained from traditional location algorithm decreases accordingly, when the node density increases to 8%, the location errors obtained from two location algorithm are close, on the whole, the weighted location algorithm can obtain the smooth location error. Therefore the new monitoring system of pollution discharge in chemical enterprise based on the Internet of things can obtain better effect.

CONCLUSION

The Internet of things is applied in the monitoring system of pollution discharge in chemical enterprise, and the resources for managing the pollution discharge in chemical enterprise are integrated together. And the pollution managing level of the chemical enterprise can be improved, and the reliability of the monitoring system can be improved. The working environment of chemical enterprise is good, and then the social benefits of the chemical enterprise are improved.

REFERENCES

[1] JF Peng, YH Song, P Yuan. Journal of Environmental Sciences, **2013**, 25(7), 1441-1449
[2] JL Xue, DF Zhao, JG Cheng. *China Petroleum Processing & Petrochemical Technology*, **2013**,(4), 33-37.
[3] Y Wang, X Wang, *Journal of Chemical and Pharmaceutical Research*, **2014**, 6(6), 661-668.
[4] SM Zhang, SX Zhang, FQ Wu. *Journal of Chemical and Pharmaceutical Research*, **2014**, 6(4), 69-74.
[5] YG Chen, ZL Zhang, ZY Hu. *Journal of Chemical and Pharmaceutical Research*, **2014**, 6(3), 723-728.
[6] J Li, LN Zhang, WN Wang. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 571-574.
[7] H Wu, DW Seng, XJ Fang. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 560-564.
[8] XP Shang, RT Zhang, YC Chen. *Journal of Electronic Commerce in Organizations*, **2012**, 10(3), 44-55.