

Research on the Control of Centrifugal Pump System and Parameter Monitoring and Prediction System in the Chemical Industry

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Abstract

The centrifugal pump system, which is the power core of the chemical industry, is an important industrial equipment. Although its structural principle is the same as that of ordinary water pumps, due to different working environments and purposes, many industrial parameters need to be monitored during operation. The centrifugal pump itself also needs to be monitored. Traditional monitoring methods can only collect the current parameters, which is inefficient. This study is based on traditional monitoring, A new type of monitoring system has been designed, which can predict the future status of centrifugal pumps well after correction. It is of great significance for the maintenance and repair of centrifugal pump systems and the safety production of enterprises.

Keywords

Centrifugal Pump; Monitoring System; Prediction.

1. Introduction

The chemical industry is a fundamental industry that is related to the national economy and people's livelihood. People's daily life and production cannot do without the chemical industry, from the petrochemical industry, which is a pillar industry of the national economy, to the manufacturing of basic daily necessities such as soap and towels. When it comes to industry, everyone knows that our country's industry has undergone several major changes from being impoverished before the founding of the People's Republic of China to now. [1]As an important component of national industry, the chemical industry is also constantly upgrading and updating. This article studies centrifugal pumps in the chemical industry, which are one of the important power equipment in the chemical industry. The production, manufacturing, and maintenance of centrifugal pumps play an important role in the production process of the chemical industry, All operations during the production process must strictly follow the usage procedures to ensure safety. Safety in industrial production is a timeless proposition, and safety production is particularly important in the chemical industry. If accidents occur in the chemical production process, they can cause economic losses, and in severe cases, personnel injuries. Therefore, we need to conduct in-depth research on how to ensure the safety of centrifugal pumps in chemical production. The safety of centrifugal pumps cannot rely solely on human observation, as human consciousness and thinking are difficult to ensure long-term concentration. Over time, it is inevitable that omissions may occur. Therefore, the development of a safety monitoring system for centrifugal pump equipment is very important.

2. Introduction to the Working Principle and Structure of Chemical Control Centrifugal Pumps

A centrifugal pump consists of an impeller, chamber, inlet valve, outlet valve, and motor equipment.[2] It is mainly driven by the motor to rotate the impeller, generating centrifugal force.

The centrifugal force drives the liquid entering the centrifugal pump chamber to rotate, pressing the liquid into the outlet and providing it for use by other equipment or entering the next process for processing. In the chemical industry system, a certain amount of liquid is required to enter the centrifugal pump, and there are two main control methods: one is to adjust the opening of the inlet valve, and the other is to control the speed of the motor equipment. Changing the opening of imported valves is easy to control and will not be easily affected by external interference, but it cannot accurately control the adjustment accuracy. [3] In addition, adjusting requires a long time and generates significant errors; Changing the speed of the motor can more accurately control the amount of liquid entering, but precise control of the motor speed is required. In addition, centrifugal pumps in the chemical industry need to be cooled down because the temperature of the liquid that needs to be transferred is too high, which can easily cause the temperature of centrifugal pumps and related equipment to be too high, resulting in equipment damage. Therefore, appropriate cooling equipment is very necessary.

3. Introduction and Main Issues of Monitoring System for Chemical Industry Control Centrifugal Pump

In the chemical industry, there is a high demand for the monitoring system of centrifugal pump equipment, which not only requires a large number of monitoring parameters, but also high precision and speed requirements for monitoring parameters. The commonly used centrifugal pump monitoring includes flow detection, head detection, temperature detection, vibration and displacement detection, noise detection, speed detection, liquid level detection, etc. Flow detection is mainly used to monitor the amount of liquid entering the centrifugal pump every minute, using a flow meter with a counting unit of L/s; Head detection is mainly used to monitor the liquid pressure at the inlet and outlet of centrifugal pumps, as well as the pressure of cooling water and lubricating oil. The tool used is a pressure gauge, measured in meters; Temperature detection is relatively easy to understand. In addition to temperature detection for liquid transmission, it also includes the temperature of centrifugal pump bearings and sealing equipment. Although temperature detection is relatively simple, it is very important because if the equipment operates for a long time at high or low temperatures, it is not only prone to damage but also reduces its service life. This is very fatal for a production line, so temperature monitoring and alarm systems are crucial.

In addition to temperature detection, vibration and displacement detection are also very important because equipment is inevitably affected by the environment during use, such as climate, dust, temperature, etc. These parameters are likely to deviate from ideal conditions, which can cause equipment wear and tear. This kind of wear and tear is easily overlooked, leading to production safety hazards. By detecting vibration and displacement, this problem can be effectively solved, Because data cannot lie, it is easy to determine the condition of the equipment and arrange timely maintenance or replacement based on its condition. The detection of noise is mainly based on the impact on the external environment and the health considerations of workers. The production of the chemical industry not only needs to consider production capacity, but also the environment. Nowadays, industry advocates green production, especially in the chemical industry. Noise is also a kind of impact. Excessive noise can cause adverse effects on the surrounding environment, seriously affecting production and daily life. The impact on operators is even more severe, as it is difficult to recover from hearing loss, so controlling noise is very important.

The speed of a centrifugal pump mainly depends on the motor drive. Different liquid raw materials require different centrifugal pump speeds, which requires controlling the motor speed. [4] The control of motor speed includes sliding resistance method, voltage method, frequency conversion method, and pole changing method. The corresponding motor control model and speed control method need to be selected according to the model of the centrifugal pump. There are many types of motors, mainly including DC motors, AC motors, control motors, etc. In actual industrial production, AC asynchronous motors are widely used because they have a simple structure, mature manufacturing

process, numerous models on the market, and convenient power supply. Most centrifugal pumps are controlled by AC asynchronous motors. The control of motor speed is now applied to many frequency converters, because the manufacturing process of frequency converters is very mature, easy to install and use, and the cost is not high. The alarm system settings are also very complete.

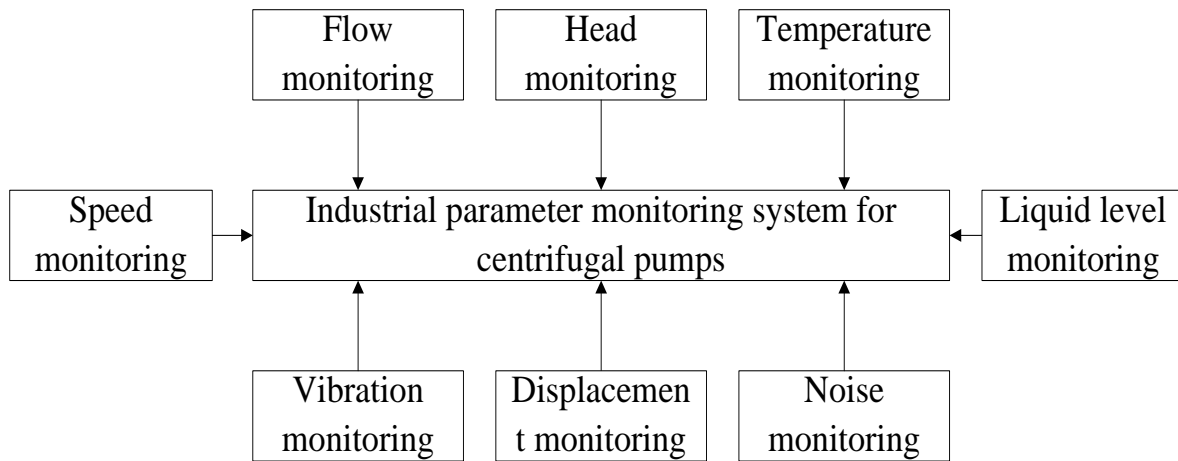


Figure 1. Industrial parameter monitoring system for centrifugal pumps

4. Chemical Control Centrifugal Pump Monitoring System and New Data Prediction Scheme

Based on the previous introduction, we already know that a centrifugal pump is not a separate device, but a relatively complex system.[5]In addition to the centrifugal pump equipment itself, there are also many detection devices for the normal operation of a centrifugal pump. Through the previous introduction, we found that the detection equipment of centrifugal pumps mostly monitors the periphery of the centrifugal pump, but there is little monitoring of the centrifugal pump itself. In fact, the maintenance and monitoring of the centrifugal pump itself are also crucial. Although the manufacturing process of centrifugal pumps is mature, loss and damage are inevitable during use. The most commonly used method now is regular maintenance, which can reduce the occurrence of accidents, However, there are situations where monitoring is not timely and equipment conditions are not understood. Therefore, this article designs a predictive centrifugal pump monitoring system to monitor and understand the working conditions of centrifugal pumps in real time. The centrifugal pump prediction and monitoring system designed in this article can not only query the historical data of the centrifugal pump in real time, but also predict the future data of the centrifugal pump. The specific method is to record the data of the centrifugal pump in the early stage, predict the next data through intelligent algorithm functions, and correct the predicted data based on the actual data after maintenance time. After several rounds of data correction, the working condition data of the centrifugal pump can be accurately predicted.

Taking the service life data of a centrifugal pump as an example, we input the on-site data, 3-month maintenance data, and 6-month maintenance data of the centrifugal pump into the monitoring system. By using the prediction function designed in the monitoring system, we can return a linear fitting curve. The value of this curve is the service life curve of this centrifugal pump. By September and December, after correcting the actual data, we can then regenerate the service life curve of the centrifugal pump based on the prediction function, It is possible to predict the service life of the centrifugal pump in the second year, and the more testing data, the more accurate the prediction will be.

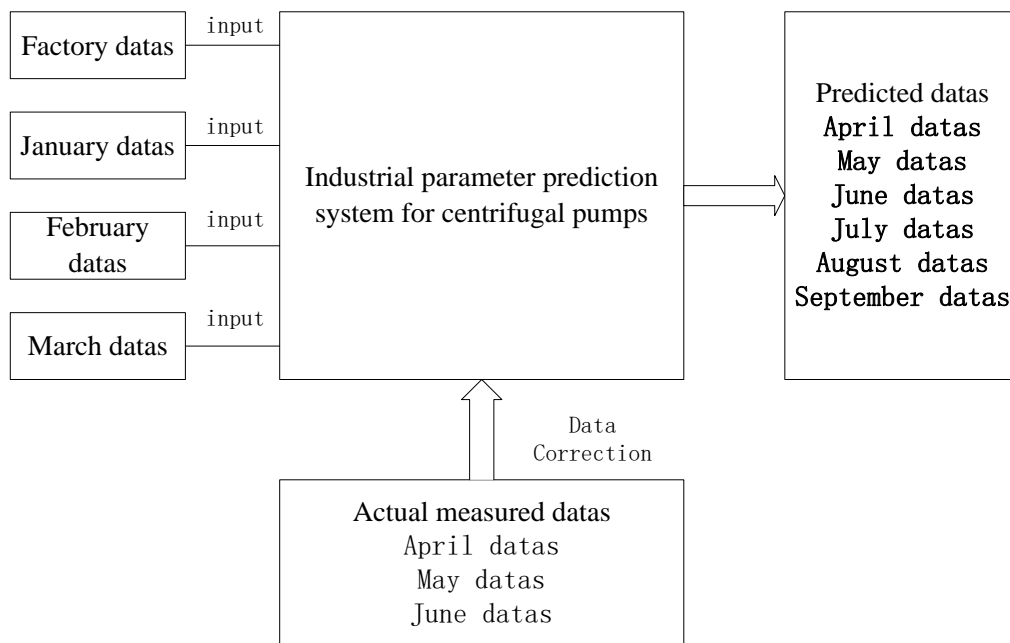


Figure 2. Parameter prediction system for centrifugal pumps

If there are hundreds of centrifugal pumps in a large group, and the data of each centrifugal pump is recorded, we can summarize and organize them to identify the key reasons that affect the service life of the centrifugal pump. If we correct this working condition, we can create huge benefits for the enterprise. The lifespan is just one parameter of a centrifugal pump. If we monitor 10 parameters, and summarize them, we will have a very good understanding of the working condition of the centrifugal pump. Based on the situation, we will make corrections and improve the working condition of the centrifugal pump to be close to optimal, and the production efficiency to be the highest. If we apply the same method to other devices, we can generate data for the entire production line, greatly improving work efficiency.

5. Conclusion

This article provides a detailed introduction to the main power equipment of the chemical industry, centrifugal pumps, and their monitoring systems. A predictable new type of monitoring system is designed, which has a good predictive effect on the fault detection of centrifugal pumps. It is of great significance for the safety production of enterprises. The new monitoring system fills the gap in the future prediction of monitoring systems and improves operational efficiency for practical industries. Reducing the human cost of personnel and equipment has a good promoting effect on the industrial upgrading of chemical enterprises and towards intelligent production.

References

- [1] Yang Lele. Parameterized design and internal flow field simulation research of centrifugal pumps [D]. Yanshan University, 2017.
- [2] Su Junsheng. Basic Skills for Chemical Machinery Maintenance [M]. 2nd Edition. Beijing: Chemical Industry Press, 2011.
- [3] Sun Yueming. General fault diagnosis and solution measures for chemical centrifugal pumps [J]. Chemical Design Communication, 2018.
- [4] Lai Anniversary. Optimization and Control of the Working Condition Adjustment Process of a Parallel Pump System [D]. Zhejiang University, 2017.
- [5] Qiu Junpeng. Design and Development of an Android based Condition Monitoring System for Centrifugal Pump Units [D]. Central North University, 2017.