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Converter station water-cooled pump vibration monitoring and condition assessment system based on LabVIEW

Huang Shan, Fang Yu

(College of Mechanical Engineering, Shanghai University of Engineering Science, Shanghai 201620,China)

ABSTRACT :*In High Voltage Direct Current(HVDC) Transmission Systems, high intelligence and reliability is demand more. It's urgently necessary to run a real-time monitoring system on converter station water-cooled pump. From the functional requirements of the monitoring system, describes the structure of the proposed converter station water-cooled pump vibration signal monitoring systems, data acquisition unit of hardware and software systems. In accordance with vibration severity in GB/T 29531-2013, As a water-cooled pump monitoring and early warning threshold, based on LabVIEW, We developed a water-cooled pump monitoring system software. Test results show that the system can effectively monitor the water-cooled pump's working conditions.*

Keywords : *LabVIEW, water-cooled pump, Vibration Monitoring, vibration severity*

I. INTRODUCTION

As the core device of HVDC system, Converter valve at runtime will generate a lot of heat. To ensure the normal operation of the converter valve, it must be cooled. Therefore in converter valve HVDC system the cooling system is particularly important. It can be said that the converter valve cooling system is a prerequisite for stable operation of the HVDC system. According to incomplete statistics,, from 2004 to 2010 nine converter station under the jurisdiction of a company has 52 single and double Atresia 10 times is caused by the valve and other assist cooling system failure. water-cooled pump as the primary cooling system of the converter valve core equipment, Mainly to provide power for the circulation of cold water for cooling. Therefore, reliable and stable working of the water-cooled pump is very important.

This paper presents a converter station water-cooled pump vibration monitoring and condition assessment of a system based on LabVIEW. The system is applied with Fengjing converter station of Shanghai Electric Power Company. Field test results show that The system can effectively monitor and evaluate the operational status of the water-cooled pump.

II. SYSTEM COMPONENTS

A System Design

Condition monitoring and fault diagnosis of electrical and mechanical equipment can be used to monitor and diagnose a lot of information ,Including vibration, temperature, pressure, current, etc. The vibration signal can quickly directly reflect the rotating machinery running status. According to statistics, more than 70% of failures are Performanced in the form of vibration. It's an effective method that the vibration signal

acquisition to achieve its status monitoring and fault diagnosis. The system consists of vibration sensor to detect the pump vibration signal after signal conditioning circuits, and A / D converter into the PC, the LabVIEW software for analysis, processing, storage and display.

B System Hardware

Hardware in The system: PC, data acquisition cards, sensors and collection devices .Hardware structure shown in Figure 1.

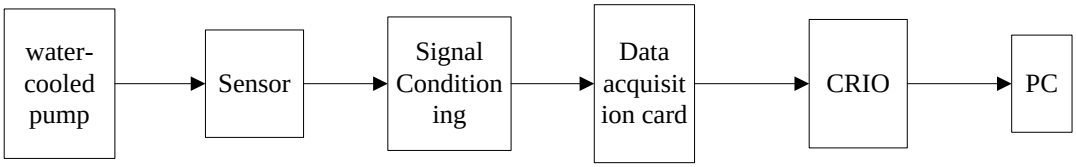

Fig. 1 Hardware diagram

C Sensor

The system use INV9832 triaxial accelerometer Sensor and INV9822 axis acceleration sensor Data collection for Data collection. Features of the Both sensors are low-impedance output, Strong anti-jamming, Little noise, can extend the cable output. The Sensitivity of INV9832 triaxial accelerometer Sensor is 100mv/g,Upper limit is 50g, frequency Range is 0.5 KHZ to 5KHZ. The Sensitivity of INV9822 axis accelerometer Sensor is 100mv/g, Frequency Range is 0.5 KHZ to 5KHZ.

D Sensor distribution

Sensor distribution position is directly related to the accuracy of the test data. According to the standard. Measurement points should near the bearings. one or several key parts of the pump is selected as the Measurement points. Measurement points should be selected in the vibrational energy to the elastic foundation or other system components for delivery of parts. Measurement points should be selected bearing, at the base and outlet flange.The location and number of measuring points as shown in figure 2.

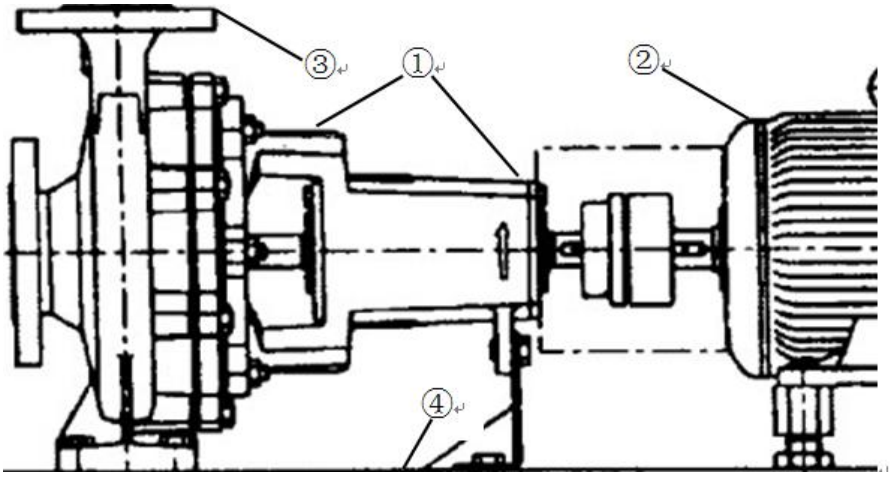

Fig.2 Sensor distribution

E data acquisition card

Selection NI 9234 multifunction data acquisition card, the relevant parameters: software-selectable IEPE signal conditioning (0 mA or 2 mA), each channel up to 51.2 kS / s sampling rate, AC coupling (0.5 Hz), 24-bit resolution, 102 dB dynamic range, anti-aliasing filter, 4-way simultaneous sampling analog input, ± 5 V

input range, compatible with smart TEDS sensors.

F Controller

NI CompactRIO (cRIO) is an industrial grade embedded control platform, compact and rugged for demanding industrial index, with wide temperature (-40 ℃ -70 ℃) and shock (50g) and other characteristics, especially for complex industrial environment for reliability-critical applications. CompactRIO system consists of a controller, the chassis (embedded FPGA chip) and acquisition module consists of three parts. CompactRIO embedded PowerPC microprocessor and FPGA chip, supports hundreds of hot-swappable I / O modules, built-in signal conditioning and digital to analog conversion circuit can be directly connected to the voltage, current, charge, ICP interfaces, electrical bridge and TEDS sensors. In addition cRIO real-time controller configured Gigabit Ethernet interface, it can be based on wired / wireless connections, build remote test system.

G System software

Software design is modular. The system is composed of signal acquisition, data analysis and processing, data display, data management, alarm and other modules. The advantages of using modular design that reduces design complexity, easy to debug and upgrade software reuse and systems. LabVIEW programming method differs from traditional programming methods, which get rid of the problems of traditional linear structure of language. Because LabVIEW execution order is determined by the way the data flow is determined, rather than lines of code appear in the order, so you can design a flow chart of simultaneous execution of multiple programs. you can select the required control and data display objects from the control panel when you design Interface. Just operating on PC panel, monitoring tasks can be done. System interface and Software Process shown in figure 3 and figure 4.

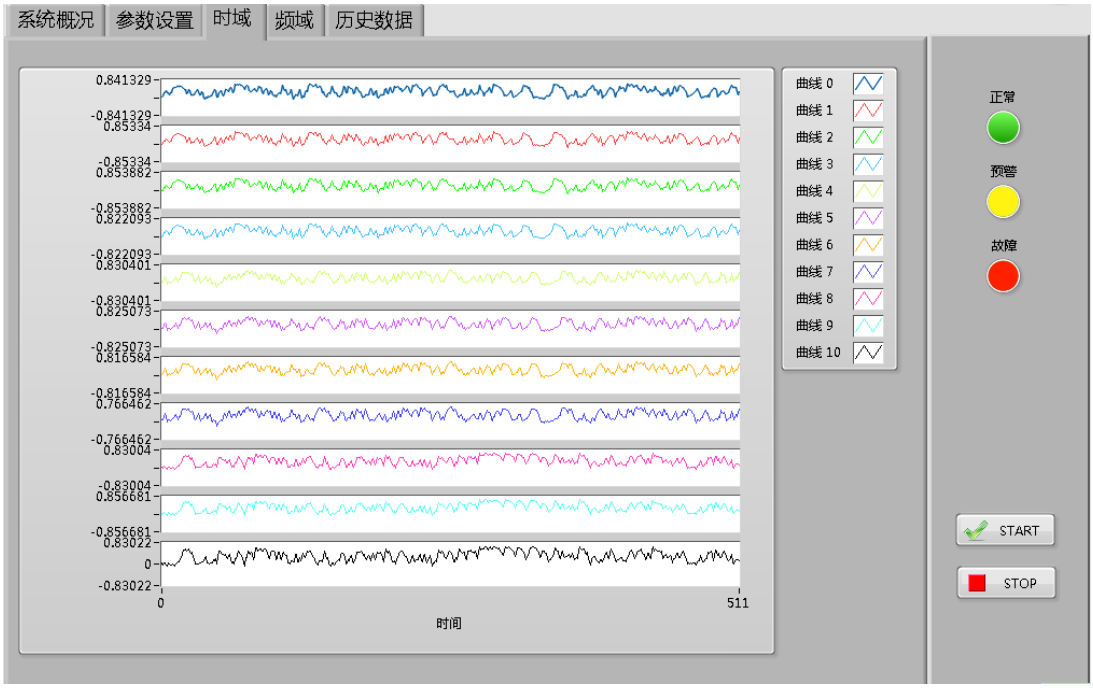

Fig.3 System interface

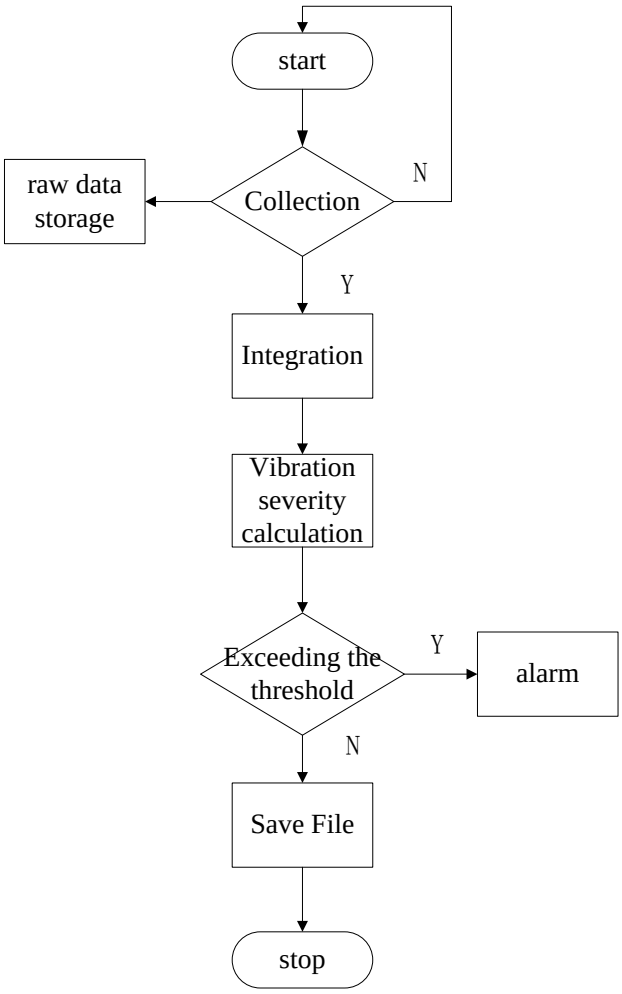

Fig.4 Software Process

H Warning criterion of choice

Selection vibration velocity in the international standard parameters as a measure of vibration severity. Vibration velocity can reflect the energy of vibration. Structural damage in machine and equipment are most due to vibrations caused by excessive speed. Noise and vibration is proportional to the speed of the machine. So we use the vibration severity (root mean square value of vibration velocity) as the standard for judging parameters.

Class	Center height（mm）and Speed（r/min）		
	≦225mm	＞225mm~550mm	＞550mm
First Class	≦1800r/min	≦1000r/min	——
second Class	＞1800r/min~4500 r/min	＞1000r/min~1800 r/min	＞600r/min~1500 r/min
Third Class	＞4500r/min~12000 r/min	＞1800r/min~4500 r/min	＞1500r/min~3600 r/min
Fourth Class	——	＞4500r/min~12000 r/min	＞3600r/min~12000 r/min

The converter station pump type is CPKN-C1 200-500, Rated flow is 380m3/h, Head is 60m, Rated speed is 1488r/min, Center height 425mm, So the pump is second class.

I Evaluation of pump vibration levels

Pump vibration levels are A, B, C, D four, D is unqualified

Table 1 Evaluation of pump vibration levels

<table>
<tr><td rowspan="2">vibration severity level(mm/s)</td><td colspan="4">Evaluation of pump vibration levels</td></tr>
<tr><td>First Class</td><td>second Class</td><td>Third Class</td><td>Fourth Class</td></tr>
<tr><td>0.28</td><td rowspan="3">A</td><td rowspan="3">A</td><td rowspan="5">A</td><td rowspan="6">A</td></tr>
<tr><td>0.45</td></tr>
<tr><td>0.71</td></tr>
<tr><td>1.12</td><td rowspan="2">B</td></tr>
<tr><td>1.80</td><td rowspan="2">B</td></tr>
<tr><td>2.80</td><td>C</td><td rowspan="2">B</td></tr>
<tr><td>4.50</td><td rowspan="6">D</td><td>C</td><td rowspan="2">B</td></tr>
<tr><td>7.10</td><td rowspan="5">D</td><td>C</td></tr>
<tr><td>11.20</td><td rowspan="3">D</td><td>C</td></tr>
<tr><td>18.00</td><td rowspan="3">D</td></tr>
<tr><td>28.00</td></tr>
<tr><td>45.00</td></tr>
</table>

III. Test and Analysis

The test site in Jinshan District of Shanghai Fengjing converter station. Test objects is the converter station water-cooled pump. Test conditions: Normal operating conditions, Speed 1488r / min, Sampling frequency 2560Hz, Sampling time 1h, Figure 5 test site.

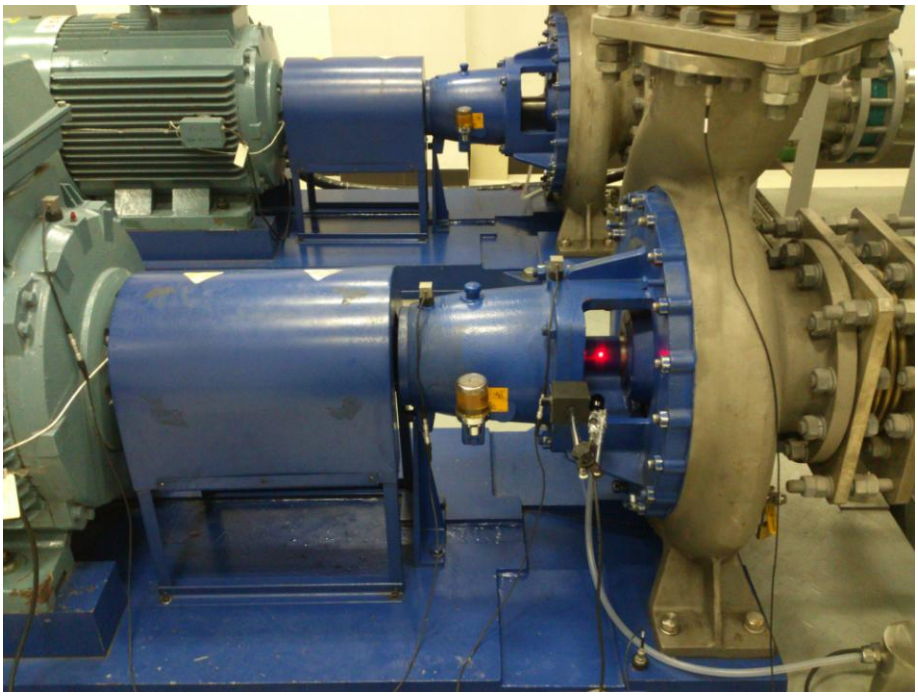

Fig.5 Test results and analysis

Table 2 Test results

No.	1	2	3	4	5	6	7	8	9	10	11
Unit	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s	mm/s
vibration severity	1.19	0.96	0.77	0.95	0.74	0.95	1.34	0.66	0.76	0.57	0.62

According to The second type pump vibration level parameters in fig 2, We can see the five measurement points of 11 vibration severity did not exceed 2.8 mm / s.Is's in B CLASS, the pump is operating normally.

IV. Conclusion

In this paper, we build a converter station water-cooled pump vibration monitoring and evaluation system based on LabVIEW. introduce hardware selection and the design of PC software in monitoring system. The test system hardware structure is simple, Portability. Software platform applicability and scalability. The system can monitor converter station cooling pump status real-time, carry out effective analysis of vibration signals obtained by the sensor. In accordance with the pump vibration testing standards to assess operating status. Provide the basis for condition-based maintenance. Ensure the safety of converter station water-cooled pump working stable.

V. Acknowledgements

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