Design of Deformation Measuring Device

Yan Liu, Xincai Chang* and Jishi Guan
China Nuclear Power Technology Research Institute, Beijing, China

*Corresponding author e-mail: changxincai@cgnpc.com.cn

Abstract. This paper designs a set of testing tools for mechanical processing, which can be used to measure the deformation and residual deformation of several bolts during hydraulic tension, to evaluate whether the pressure vessel meets the installation requirements, and to protect the bolts from being damaged by over-designed pressure tension during hydraulic tension.

1. Introduction
Pressure vessel of nuclear power plant reactor is generally a large nuclear-level facility, and its installation technology must be very mature [1, 2]. In order to ensure the validity of pressure vessel installation, it is necessary to remove the support ring and the protective layer on the surface of the support surface of pressure vessel, and use acetone for cleaning. The adjusting bolt in the supporting ring is adjusted to meet the design requirements. The pressure vessel is put into the deep pit by ring crane, then the orientation of the pressure vessel is adjusted, and the center line of the vessel flange is agreed with the installation standard. Then the pressure vessel is placed above the support bolt and the elevation, level and center line of the pressure vessel are measured, and the support bolt is adjusted to ensure that the elevation and horizontal deviation of the pressure vessel can fully meet the design requirements [4]. In order to measure the gap between the support block and the support surface and to adjust the pressure vessel, the accuracy of the gap measurement must be very accurate.

The installation process of pressure vessel in nuclear power plant is complicated, especially in the aspect of vessel installation and modification [3], which can easily affect the quality of pressure vessel. For this reason, a set of deformation measuring device is designed to measure the shape of multiple bolts in the process of hydraulic tension for nuclear power plant reactor pressure vessel. Variables and residual deformation are used to assess whether the pressure vessel meets the installation requirements.

2. System overall design
Deformation measurement system is used to measure the deformation and residual deformation of many bolts in real time during tension. It is mainly composed of deformation measurement instrument, multi-channel data acquisition device, PLC and an industrial control unit. The system structure is shown in Figure 1.
3. Multiplex Data Acquisition Device

The multi-channel data collector in the system is used to collect the data and switching signals of the deformation measuring instrument. Its functions are as follows:

1. A single data collector can collect the data of eight measuring instruments, upload them to PLC and then upload them to industrial computer, and monitor the communication status. An indicator lamp can display the communication status.

2. A single data collector can receive 32 switching signals and upload them to the industrial computer to monitor the operation status of the deformation measuring device, alarm remote faults, and display the signal status with an indicator lamp.

3. Input data format should be compatible with deformation measurement instrument data format;

4. The power supply of the data collector is 24VDC. Each data collector can provide communication and power connection for the next data collector.

5. Multiple data acquisition communicators communicate with PLC through MODBUS bus. Cables are required to have low smoke and halogen-free flame-retardant characteristics.

6. The acquisition is real-time and meets the requirement of 0.5 seconds refresh of upper computer data.

3.1. Interface mode

1. The interface between deformation measuring instrument and data collector is SPC data communication interface.

2. Switching signal and data acquisition interface, PNP or NPN switch output, high voltage 24V;

3. Data collector communicates with PLC and data collector through MODBUS bus.

3.2. Hardware design

The data collector realizes the acquisition and conversion of 8-channel instrument signals into Modbus protocol, and provides 24V power supply for the field.

Mcpu polls every 300 milliseconds to read 8-way data and switch status. Data reading: Through REQ pin and corresponding instrument communication connection, data reading. Switch quantity reading: 32 switch quantity states are read by four address latches respectively. All data are filled into the specified
array according to Modbus protocol, waiting for the host computer to read through 485 bus. Adding opt coupler in the middle is the protection of the product.

485 communication, baud rate set to 9600 or 19200, you can set the 485-communication address of the product through the protocol, you can also set the address in hardware mode on the device. The host computer can read the data of the device through the protocol. Data is updated regularly.

The external interface of data acquisition device is aviation plug, which is used to upload test instrument and switch signal.

Figure 2. Schematic diagram of data acquisition equipment

As shown in Figure 2, the data acquisition unit is divided into the following parts.

(1) The upper part is 32 channels of switching signals, which are processed by 15 pin terminals or lead out in the box and shielded by wire.

(2) In the middle are 8 channels of instrument signal acquisition, each channel has an independent customized cable, which is connected with the equipment through an aviation plug.

(3) The following is the power supply and communication part. In the power supply part, the internal power supply of the equipment is provided by the 24-power supply of the upper level, and the 24-power supply is drawn out for the use of the lower level. For the communication part, the left side is the Modbus output connection PLC (only the first box has this function through the built-in dial switch). On the right is the internal communication protocol port and the cascade interface between the devices.

4. System software design
The design of this system adopts three-tier communication control mode. Industrial computer and PLC are the upper man-machine interaction functions. They communicate with the lower computer equipment through 485, transmit operation instructions, receive the data collected by the lower computer and process and display them. The lower computer responds to the instructions to realize the functions of data acquisition and upload.

5. Conclusion
In this paper, a set of deformation measuring device is designed to measure the deformation and residual deformation of several bolts in the process of hydraulic tension. The measuring device in this paper can strengthen the technical level of nuclear power plant reactor pressure vessel installation, guarantee the quality of pressure vessel and promote the development of nuclear power plant technology in China.

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