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RESEARCH AND VERIFICATION OF TEMPERATURE TEST FOR LARGE WEIGHING INSTRUMENTS

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Abstract:
This paper proposes a research and development of a non-weight intelligent detection equipment and method for temperature testing of large weighing instruments. By analysis the technical problems currently faced by weighing instruments temperature testing, under the test method and requirements for weighing instruments temperature test in OIML R 134, a design and test method of weighing instruments simulation device is proposed, and the supporting high and low temperature test automatic addition and unloading test equipment is developed. The test results prove that the measurement method solves the technical problems of the high and low temperature test of large weighing instruments, realises the intelligent detection of weighing instruments without weights under the temperature alternating environment, eliminates the impact of weighing instrument creep, and improves the work efficiency of weighing instruments temperature measurement.

Keywords: large weighing instruments; temperature test; technical problem; strategy research; verification

1. INTRODUCTION

Weighing instrument is a kind of measuring instrument that determines the mass of the object by gravity acting on the object, which is mainly divided into non-automatic weighing instruments and automatic weighing instruments, which include continuous totalising automatic weighing instruments, discontinuous totalising automatic weighing instruments, automatic catchweighing instruments, automatic gravimetric filling weighing instruments, automatic rail-weighbridges and automatic instruments for weighing road vehicles in motion. At present, the mandatory management measuring instruments included in China are non-automatic weighing instruments and automatic instruments for weighing road vehicles in motion, and the corresponding international recommendations are OIML R 76 and OIML R 134.

International recommendations OIML R 76 "Non-automatic scales" A.5.3 and OIML R 134 "Automatic instruments for weighing road vehicles in motion" A.7.2.1, A.7.2.2 have put forward specific requirements for temperature tests, but the temperature test of large weighing instruments has always been a problem in its type evaluation, and the mismatch between the size and working principle of the high and low temperature test chamber causes large weighing instruments to be modular tested, that is, the key components of the weighing display and the load cell are tested. However, the module test is not enough to prove the ability of the whole machine to maintain the metering performance in the alternating environment of high temperature and low temperature, such as the impact of other accessories on the metering performance when the environment changes, as well as the installation design, connectors and so on.

In view of the above situation, this paper analysis the main problems faced by the temperature test of large weighing instruments on the basis of the temperature technical requirements of the international recommendation OIML R 134, designs a simulation device that can fully represent the large weighing instruments, develops a non-weight intelligent detection device and method for temperature testing of large weighing instruments, and fully verifies it through a large number of tests. It has been verified that the device and method realise the temperature test detection of large weighing instruments with reliable data.

2. DESCRIPTION OF THE WORK

2.1. Temperature Test Requirements

The temperature test project includes two items: static temperature and temperature effect on the no-load indication, usually these two items are tested together. The sequence of static temperature tests is: a) reference of 20 °C; b) specified high temperature;

c) specified low temperature; d) 5 °C; e) reference of 20 °C.

Weighing test on the weighing instruments at each temperature. The test loads selected shall include Max and Min and values at or near those at which the maximum permissible error changes. All functions shall operate as designed. All errors shall be within the maximum permissible errors.

The instrument shall be set to zero and then changed to the prescribed highest and lowest temperatures as well as to 5 °C if applicable. After stabilisation the error of the zero indication shall be determined. The change in zero indication per 5 °C shall be calculated. The changes of these errors per 5 °C are calculated for any two consecutive temperatures of this test [1].

The sequence for temperature tests is shown in Figure 1.

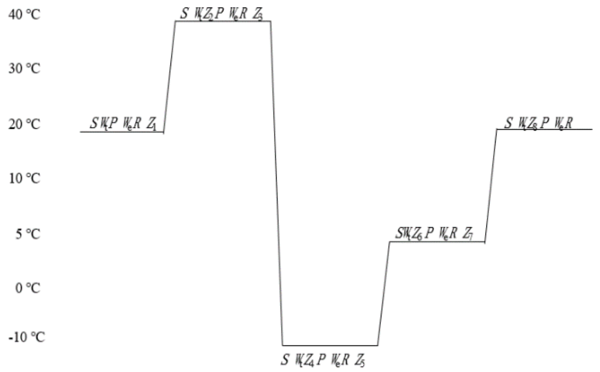

Figure 1: The sequence for temperature, where S is weighing instrument has reached temperature stability, W_t is waiting time (2 hours), P is preload, W_e is weighing test, R is recovery, Z_i is zero reading

2.2. The Technical Problems Currently Faced by Large Weighing Instruments Temperature Test

The main measuring equipment for temperature testing is the high and low temperature humid heat test chamber. The temperature test mainly evaluates the resistance of the weighing indicators, the load cell and its connector to temperature and humidity changes in the core components of the scale. The technical problems faced by the temperature test of large weighing instruments are as follows:

Measuring Equipment and Weighing Instrument Size do not Match

The size of large weighing instruments is generally in a few metres or even tens of metres, when testing, it is necessary to crane, forklift, and check truck as auxiliary equipment for lifting and unloading weights, and the measuring equipment for temperature does not have the conditions for installing cranes or passing check trucks.

Measuring Equipment and Test Requirements for Conflicts

The environmental requirements of weighing instruments shall be performed at a steady ambient temperature, without vibration and airflow. The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the given instrument without being greater than 5 °C (2 °C in the case of a creep test), and the rate of change does not exceed 5 °C per hour [2]. However, the high and low temperature test chamber workers will have a large air flow in the process of heating, cooling and constant temperature, and the walk-in high and low temperature test chamber needs to open the door of the temperature chamber to test. Due to the large temperature difference between the inside and outside of the temperature chamber, the temperature shock phenomenon will affect the stability of the environment, and even exceed the maximum temperature difference required by the test, exceeding 5 °C [3]. And the large scale plus unloading time is long, if in order to avoid air flow to stop the fan of the high and low temperature test chamber, the long test time is easy to cause large temperature fluctuations.

Disadvantages of the Modular Test Method

The module test of the load cell and the weighing indicators respectively cannot fully prove whether the high and low temperature performance of the whole machine is good. The author has done a type evaluation of a small scale, and its key module load cell and weighing display have obtained a type evaluation report, but when the whole machine conducts high and low temperature tests, the value instability occurs at high temperatures. After investigation, the line glue used melted and stained the load cell at high temperatures, resulting in numerical instability.

2.3. Strategic Study of Large Weighing Instruments Temperature Testing Inspection Equipment and Methods

In view of the technical problems encountered in the environmental test in the inspection and type evaluation of large weighing instruments, in line with the test requirements of the specification OIML R 134 and R 76 for the analysis weighing instruments, a new intelligent detection system is developed, which includes a high and low temperature box and a force standard comparison machine.

Inspect the Main Structure of the Equipment

The main engine structure is mainly composed of cylinders, frames, standard sensors, temperature and humidity boxes, mobile tables, guide rails, etc.

The main frame adopts a portal trapezoidal structure, which is mainly composed of the upper beam, the main column and the base, and the equipment structure is shown in Figure 2.

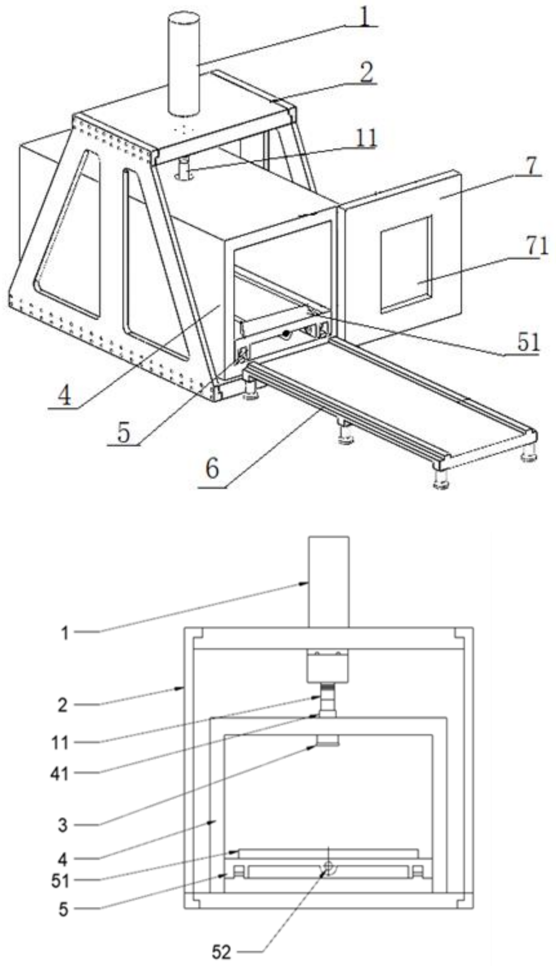

Figure 2： Schematic diagram of the structure of the inspection equipment

Verify the Operation of the Equipment

Place the whole simulation tooling of the weighing instrument (including weighing indicators, load cells, connector, etc.) The mobile workbench 5 is transported to the test position, close the incubator box door, when placing the scale, according to the size of the scale, by adjusting the ball screw 52 to change the distance between the two sets of plates 51 and close to the position on both sides of the scale, the plate 51 as a reference to the position of the scale, so that the scale can be basically placed in the position directly below the standard sensor 3 after being sent to the incubator 4, so that the loading force can be placed in the centre of the scale bearer as much as possible during loading, so that the force is uniform; Standard sensor 3 in the cylinder piston where the load weight is applied is in contact with the load carrier of the measuring scale and adjusts the zero position. According to the technical requirements of OIML R 76, R 134, pre-set a plurality of measurement standard load values equivalent to loading weights, through the computer system to start the CNC servo hydraulic control system to make the cylinder 1 move downwards, cylinder 1 through the standard sensor 3 to the scale to be measured to transmit the load, wait for the force value to stabilize to the pre-set value, the controller controls the cylinder 1 to stop loading, automatically record the reading through the computer system, while observing the value on the monitor to be measured through the observation window 71 and compare with the loaded value, Determine whether the indication error of the scale simulation device exceeds the maximum allowable error of the specification. According to the technical requirements of OIML R 76 and R 134, the temperature of the incubator 4 is adjusted, and the temperature test can be carried out multiple times to automatically complete the high and low temperature detection of the scale simulation device.

Technical Specifications of the Equipment

Measuring range (0 ~ 50) t, measurement accuracy ±0.02 %, internal size 2 500 mm × 1 000 mm × 800 mm, can with stand the mass range of the analyte (10 ~ 200) kg, the sensors have ranges of 100 kN, 300 kN and 500 kN and an accuracy of C3, control accuracy 0.001 % FS, force value fluctuation 0.001 % FS.

Technical parameters of the temperature and humidity box: temperature range (-20 ~ +60) °C, humidity range (20 ~ 98) %RH, temperature fluctuation ±1 °C, heating rate (0 ~ 1) °C/min, cooling rate (0 ~ 0.7) °C/min. At the same time, the circulation wind speed is used to adjust the flow of the air flow to improve the working performance of high and low temperature equipment [4].

Technical parameters of the standard sensor: rated ranges of 100 kN, 300 kN and 500 kN, force direction is tensile and pressure bidirectional, sensitivity of 3.0 mV/V ± 0.1 %, excitation voltage of 5 V, accuracy is better than 0.02 %, 30 min creep is better than 0.02 %, operating environment temperature (-30 ~ +85) °C, limit load force: 150 %.

Traceability of the Quantity Value of the Inspection Equipment

The high and low temperature chamber of the inspection equipment and the comparator force standard machine were traced back to the source of the measurement value respectively. The quantity value traceability transmission diagram of the inspection equipment is shown in Figure 3.

The test equipment developed in this project can carry out high and low temperature tests of large weighing instruments with a weighing range

(0 ~ 50) t in the environment of (-10 ~ +40) °C. The device is capable of meeting the test requirements of OIML R 76 and OIML R 134 [5].

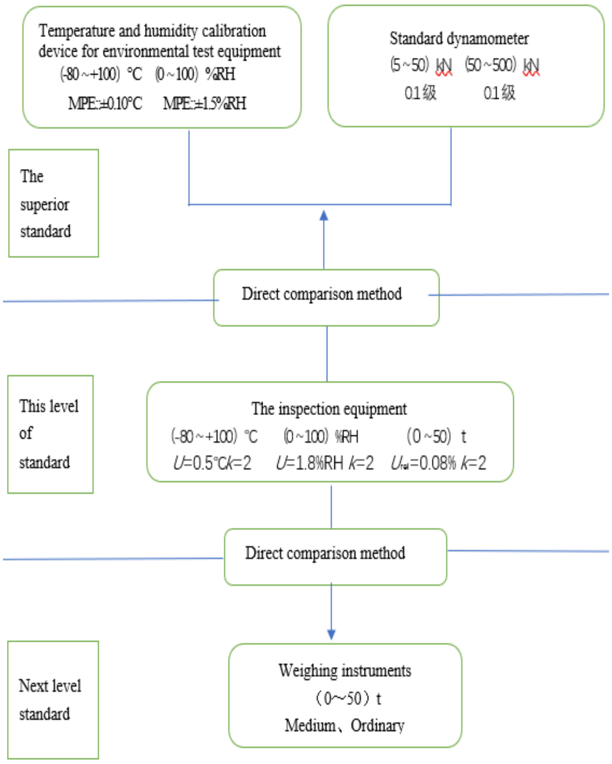

Figure 3: Traceability diagram of the quantity value of the inspection

2.4. Validation and Analysis of Inspection Data

In order to assess the adaptability, accuracy and reliability of the inspection equipment for temperature testing, the inspection equipment was used to conduct temperature tests on large scales such as non-automatic scales of different specifications and automatic scales of dynamic highway vehicles during the research process, and the test results were verified by tests, and the test results met the relevant requirements of OIML R 76 and OIML R 134.

According to the test requirements of the international recommendation OIML R 134, a static temperature test was carried out on the automatic instruments for weighing road vehicles in motion with a maximum scale of 30 t and an index value of 20 kg. Among them, the computer terminal software interface is shown in Figure 4. The connection between the inspection equipment and the device under test is shown in Figure 5. And the specified high temperature 40 °C test data is shown in Table 1, the specified low temperature -10 °C test data is shown in Table 2.

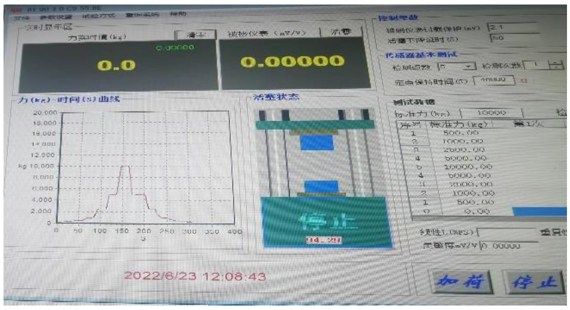

Figure 4: The computer terminal software interface

Figure 5: The connection between the inspection equipment and the device under test

Table 1: At the specified high temperature 40 °C test data, all values in kg

Standard load *L*	Instrument represents the value *I*		Corrected error E_C		Maximum permissible error
	↓	↑	↓	↑	
(*)0	0	2	/	2	10
1 000	999	1 006	-1	6	10
10 000	9 995	9 999	-5	-1	10
15 000	14 990	14 991	-10	-9	20
20 000	19 985	19 990	-15	-10	20
30 000	29 981	29 981	-19	-19	20

Table 2: At the specified low temperature -10 °C test data, all values in kg

Standard load *L*	Instrument represents the value *I*		Corrected error E_C		Maximum permissible error
	↓	↑	↓	↑	
(*)0	0	2	/	0	10
1 000	1 000	1 000	0	0	10
10 000	10 002	10 008	2	8	10
15 000	15 004	15 006	4	6	20
20 000	20 004	20 008	4	8	20
30 000	30 007	30 007	7	7	20

As can be seen from Table 1 and Table 2, the test system of the inspection equipment is running stably and can complete the temperature test of the large weighing instruments simulation device [6].

3. SUMMARY

Through the test verification, the temperature test for large weighing instruments proposed in the paper, including inspection equipment and inspection methods, realises the temperature test that is difficult to achieve for large weighing instruments, solves the problem of mismatch between the size of the high and low temperature test chamber and the scale, overcomes the long loading and unloading time of the large scale, and turns off the fan of the high and low temperature test chamber for a long time, which is easy to cause large temperature fluctuations. Real-time calibration of measurement results through automated weighing testing eliminates the effects of scale creep. Greatly improves the uncertainty and efficiency of scale temperature measurements. It solves the design problems and connector problems that may be ignored by the module test and has a good industrialisation prospect.

4. REFERENCES

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