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DEVELOPMENT OF WEIGHT HANDLING DEVICE FOR APMP ABSOLUTE PRESSURE INTERCOMPARISON, APMP.M.P-K9

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Abstract – This paper describes a newly organized APMP absolute pressure inter-comparison and a weight handling device used for this comparison. The device is specially developed for stability monitoring of transfer gauge. The pressure range of comparison is from 10 kPa to 110 kPa in the absolute mode.

Keywords: weight handling device, absolute pressure, inter-comparison

1. INTRODUCTION

Deadweight piston gauges or pressure balances are widely used to establish the pressure scale from 5 kPa to 1 GPa. Basically, a pressure balance is a piston fitted into a matching cylinder filled with gas or oil, loaded with known weights, and rotated with respect to the cylinder to help attain concentricity of the piston in the cylinder. The upward force due to the system pressure acting on the area of the piston is balanced against the downward gravitational force due to the weights. The system pressure is defined as the ratio of the downward gravitational force to the effective area of piston-cylinder unit. In order to measure absolute pressure not gauge pressure, a bell-jar to form an enclosure surrounding the piston and weights is necessary. The air inside the bell-jar is evacuated to allow absolute measurements.

Recently, authors showed the automatic weight loading device which can load and unload various weights in vacuum from 100 mg to 3.1 kg. In order to control the weights of 11 kg for this inter-comparison we are developing a new handling device. Although a commercial weight handling device is available, the minimum pressure generated inside the bell-jar is too high compared to our desired target pressure, which is below 0.1 Pa. We will use this weight handling device for the purpose of monitoring and investigating of transfer gauge used in APMP absolute pressure inter-comparison in the range of 10 kPa to 110 kPa.

2. WEIGHT HANDLING DEVICE

The weight handling device is made for use with a commercial gas operated pressure balance manufactured by DH Instruments (model 7601). Figure 1 shows the details of the new device. The original DHI pressure balance is modified, in that the glass cover that keep vacuum is replaced by a stainless steel chamber. The basic principle of operation is to lift the total weight off the piston to a weight selection position and back down onto the piston. The lifter is electrically actuated. As the weights rises, they are put on the ledge of the six weight lifting shafts.

The chamber has two rotary motion feedthroughs and one linear motion feedthrough. The two motors are located outside the pressure chamber and are used to rotate six weight lifting shafts. Three shafts are connected by timing belt and rotate simultaneously by a step motor. A piston/cylinder assembly with 35 mm diameter is used for this device. The device consists of tare weights of 1 kg and 12 weights of 1 kg which cover 10 kPa to 130 kPa. Since the piston and cylinder units have nominal area of 980 mm^2, a mass of 1 kg corresponds to a pressure of 10 kPa.

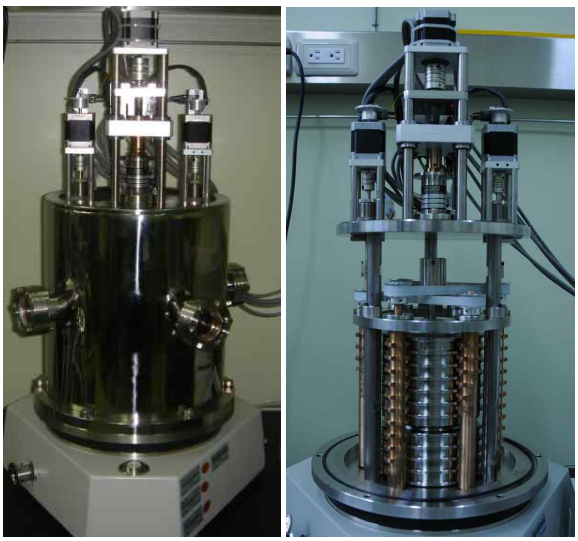

Fig. 1. Weight handling device manufactured at KRISS.

3. APMP PRESSURE COMPARISON

An absolute pressure comparison in the range of 10 kPa to 110 kPa (APMP.M.P-K9) was arranged in November 2008 at APMP TCM meeting. KRISS will act as a pilot laboratory and NMIA will act as an assisting pilot laboratory. Sixteen national metrology institutes (NMIs) expressed interest in participating in this comparison: KRISS (Republic of Korea), NML-SIRIM (Malaysia), KIM-LIPI (Indonesia), MSL (New Zealand), NIM (China), NIMT

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(Thailand), NIS (Egypt), NMC A*STAR (Singapore), NMIA (Australia), NMISA (South Africa), NPIi (India), NSCL (Syria), SCL (Hong Kong), VMI (Vietnam), NMIJ (Japan), and PTB (Germany).

Table 1 Participant List

No.	Institute	Pressure Standard	Contact Person
1	KRISS	Pressure Balance with automatic weig ht handler	Dr. S.Y. Woo Dr. I.M. Choi
2	NML-SIRIM	Pressure Balance	Dr.Wan A. Malik W an Mohamed
3	KIM-LIPI	Pressure Balance	Mr. R. Hayu
4	MSL	Pressure Balance	Mr. M. Fitzgerald
5	NIM	Pressure Balance	Ms.Yue Jin
6	NIMT	Pressure Balance	Mr. T. Changpan
7	NIS	Pressure Balance	Dr. Alaaeldin A. Eltawil
8	NMC A*STAR	Pressure Balance	Mr.Wu Jian
9	NMIA	Mercury Interfero-metric manometer	Dr.John Man
10	NMISA	Pressure Balance	Mr.Cherie Korasie
11	NSCL	Pressure Balance	Eng. M. Aldammad
12	SCL	Pressure Balance	Mr. Chan Tak Kin
13	PTB	Mercury Manometer	Dr. W. Sabuga
14	NPLi	Ultrasonic Interfero-meter Manometer	Dr. D. R. Sharma Mr. D.A.Vijayakum ar
15	VMI	Pressure Balance	Mr. N. Ngoc Con
16	NMIJ	Pressure Balance	Dr. M. Kojima Dr. T. Kobata

One transfer standard unit will be used for this comparison. It is a precise digital pressure gauge (RPM4 made by DHI, USA) equipped with two quartz reference pressure transducers (Q-RPT). They are specially selected for low hysteresis by the manufacturer. The measurement instructions will be prepared by KRISS. The measurement points are 10 kPa, 20 kPa, 30 kPa, 40 kPa, 50 kPa, 60 kPa, 70 kPa, 80 kPa, 90 kPa, 100 kPa and 110 kPa. These pressures are chosen to be evenly spread through the range of the comparison. The procedure requires that each participant carry out a calibration in an ascending and then descending sequence of pressures. At each calibration pressure, one pressure reading with standard deviation is taken. The whole procedures will be repeated three times.

Room temperature and operating gas may affect to the performance of the gauge. The transfer standard will be tested at 20 °C and 23 °C. The participants can calibrate it according to the NMI laboratory condition. Moreover, since the characteristic of the gauge with Q-RPT sensors can depend on the operating gas. Nitrogen (N_2) will be used for the comparison

Fig. 2. Transfer standard for APMP.M.P-K9.

The CCM key comparison which corresponds to this comparison is CCM.P-K2. It covers the pressure range 10 kPa to 120 kPa in absolute mode. Nine NMIs participated in the comparison, which used a piston-cylinder assembly of 335 mm^2 nominal effective area as a transfer standard. All participants in CCM.P-K2 comparison used mercury manometers as their primary standards. NMIA and PTB will be link laboratories since they participated in CCM.P-K2. Also, NMIA agreed to be an assisting pilot laboratory.

Prior to starting the comparison initial calibrations will be performed to assess the characteristics of the transfer gauge. Periodically through the comparison the transfer gauge will be returned to KRISS in order to monitor its performance. The transfer standard will be sent in one box. The transfer standard and all accompanying parts are the property of the KRISS.

4. CONCLUSIONS

This paper describes a weight handling device used for this comparison and overview of APMP.M.P-K9. The benefits of automating the weight handling are clear. Although operating principle of our device is similar with commercial ones, the lowest obtainable residual pressure inside the bell-jar is very small compared to commercial ones. This is partly due to the simple design of weight handling mechanism. We will use this device to investigate and analyze the characteristics of transfer gauge used in APMP absolute pressure inter-comparison in the rage of 10 kPa to 110 kPa.

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