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BILATERAL COMPARISON IN HRC BETWEEN NIMT AND VMI

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Abstract: This bilateral comparison in HRC was conducted in order to confirm the accuracy claimed by National Institute of Metrology (Thailand) or (NIMT) and Vietnam Metrology Institute (VMI). Also, this bilateral comparison compares the difference of measurement results between lever-type machine and deadweight-type machine of two NMIs, which are NIMT and VMI, respectively.

Keywords: Rockwell hardness, Lever-type machine, Deadweight-type machine.

1. INTRODUCTION

The Rockwell hardness national standard in Thailand was established in May 2003 and was manufactured by Akashi Corporation. NIMT carried out the bilateral comparison with NMIJ in June 2003 in order to confirm the performance and uncertainty of NIMT's Rockwell hardness standard [1], which was claimed to be within ±0.45 HRC. This bilateral comparison was done between lever-type hardness standard machines. Many NMIs use different types of Rockwell hardness standard machines, such as deadweight-type machines, lever-type machines and screw force feedback control machines for inter-comparisons. The research paper "Establishing a world-wide unified Rockwell hardness scale with metrological traceability" [2] refers to this case. A common indenter was tested using similar testing cycles. The variation range was –0.19 HRC to +0.16 HRC. The research paper "World-wide unified scales Rockwell hardness test with conical indenter" [3] cited a variation range of –0.75 to +0.47 HRC. Both researches could not distinguish the difference of measurement results from deadweight-type hardness machines and lever-type hardness machines significantly enough for the national standard level.

The direct verification of primary standard hardness machine is valid if the result is within the tolerance designated by EN ISO 6508-3 [4] without the effect of machine type. In order to emphasize this principle, this bilateral comparison between deadweight-type machine (VMI) and lever-type machine (NIMT) was conducted. This comparison also confirms the declared uncertainty of both parties.

2. COMPARISON METHOD

2.1. Measurement Method

Four sets of hardness blocks of 20, 40 and 60 HRC were used in this comparison. Two sets of hardness blocks were measured with common indenter in order to determine the performance of primary hardness machines. Another two sets were measured with each laboratory's indenter in order to confirm their declared uncertainties of hardness scale. Standard testing cycle according to EN ISO 6508-3 was used in all measurements.

The measurement consisted of 9 points of indentation. Each block was divided into 9 equal areas

2.2. Standard Hardness Machine

The standard hardness machine of VMI is the deadweight-type machine, which uses a spiral microscope for depth measurement of indentation. This machine was manufactured by VEB Germany.

The standard hardness machine of NIMT is the lever-type machine, which uses a laser hologauge for depth measurement of indentation. This machine was manufactured by Akashi Corporation Japan.

Both standard machines were directly verified according to EN ISO 6508-3 as in the measurement reports.

2.3. Standard Testing cycle

A testing cycle according to EN ISO 6508-3 was used in this bilateral comparison. It is also the standard testing cycle of NIMT. The detail of the testing cycle is as follow:

- The velocity of the indenter when reaching the surface shall not exceed 1 μm/s
- The duration of the preliminary test force shall not exceed 3 s
- The indentation speed of test force application shall be 20 μm/s to 40 μm/s
- The duration of the total test force shall be 4 ± 2 s
- The time duration before reaching permanent indentation depth shall be 4 ± 1 s

2.4. Uncertainty of Hardness Measurement

Table 1. Measurement uncertainty of laboratory

Metrology Institute	Expanded uncertainty (± HRC)		
	20 to 25 HRC	40 to 45 HRC	60 to 65 HRC
NIMT	0.45	0.45	0.45
VMI	0.31	0.31	0.31

3. COMPARISON RESULTS

3.1. Value measured with the common indenter

The measurements were carried out using the same indenter. The results are given in Table 2 and are plotted in Fig.1. The mean values of standardizing machines have a difference within ± 0.12 HRC.

3.2. Value measured with the common indenter

The measurements were carried out with each laboratory's indenter. The mean values were compared including the influence of the indenter used. The results are given in Table 3 and are plotted in Fig.3. The values are different within ± 0.26 HRC.

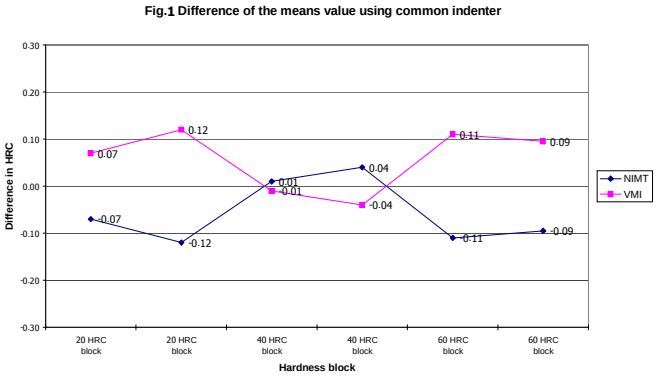

Fig. 1. Difference of the means value using common indenter

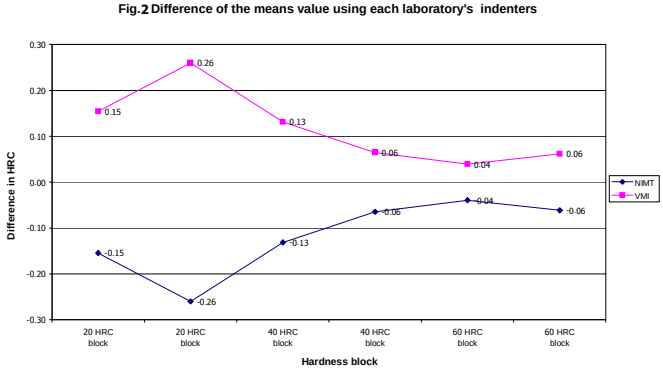

Fig. 2. Difference of the means value using each laboratory's indenter

4. CONCLUSION

The results measured with the common indenter and similar testing cycles have a difference within ± 0.12 HRC, which caused by the standard machines. This corresponds to the research paper "Establishing a world-wide unified Rockwell hardness scale with Metrological traceability" [2] and the research paper "World-wide unified scales Rockwell hardness test with conical indenter" [3]. The differences of measurement results among standard hardness machines of each NMI cited in these research papers are between –0.19 HRC to +0.16 HRC and -0.75 HRC to +0.47 HRC, respectively. Theoretically, hardness machine types should affect measurement results, but from the aforementioned trails, the difference caused by hardness machine type is insignificant. This is because each NMI's primary machine was at least directly verified according to ISO6508-3.

The results measured with each laboratory's indenter gives the variation range of ±0.26 HRC, which represents the combined variation range of different national indenters and national standard machines. This variation range is within the variation range of both aforementioned research papers, which are –0.29 to +0.38 [2] and –0.51 to +0.43 [3]. The uncertainties that both NMIs have claimed are confirmed to be within this variation range.

This bilateral comparison yielded a satisfactory comparison result between NIMT and VMI. There are future plans for bilateral comparisons in other parameters, such as Vickers.

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