Technical Information

Relevance of ASTM Standards for Equotip Testing (Leeb)

Conformance of Equotip hardness testers with the various ASTM hardness testing standards are of particular concern to users e.g. with applications in the petrochemical industry who refer to API. This document will outline the current situation within standards.

ASTM A956 (Leeb)

The Equotip range of hardness testers are standardized according to ASTM A956-06 “Standard Test Method for Leeb Hardness Testing of Steel Products”. This was originally approved and published in 1996, the standard was revised in 2012 to include the DL and S device as well. A956 is one of the main ASTM standards that highlight the testing with the Leeb portable unit.

The Leeb method measures the ratio of rebound velocity to an impact velocity from a defined impact body launched against a surface with defined impact energy. Therefore the Leeb method ultimately measures the loss of kinetic energy, and is thus considered a dynamic technique. The accuracy of a Leeb test is dependent on correct setup and test conditions – surface roughness, test piece thickness, and mass are defined in the A956 standard.

The A956 standard is not known to be specifically referenced by any current API standard however; the Equotip conveniently converts hardness measurement values and displays the results in other hardness scales, such as Brinell, Rockwell, and Vickers according to ASTM E140 (Conversions) which are generally mentioned in API guideline.

ASTM E140 (Hardness Conversions)

E140 is one of the most go to standards when it comes to any conversion requirements; This standard includes a comprehensive range of hardness conversions for metals. Leeb (HLD) is also included in this standard highlighting the conversions tables to Rockwell (HRC), Brinell (HBW10/3000) and Vickers (HV10) scales. Please note that the conversion table highlighted in E140 is for Equotip Material Group 1 (Steel & Cast Steel).

ASTM E10 (Brinell)

This standard covers the Brinell test method as used by stationary, typically bench-top machines. This standard does not apply to portable devices like the King Brinell (hydraulic force application) or comparative testers like the Telebrineller, as these devices do not conform to the force application requirements of the test method.

ASTM E18 (Rockwell)

This standard covers the Rockwell test method as used by stationary, typically bench-top machines. It does not apply to portable devices, as these devices do not conform to the force application requirements of the test method.

ASTM E110 (Portable Testers)

Portable Brinell and Rockwell testing devices are highlighted under this standard. These devices typically use the same indenter (diamond cone, tungsten carbide ball) as defined in the E10 and E18 standards. However, the devices are designed for portable use and generally do not conform to E10 and E18 for the reasons stated above. E110 is currently involved in a revision ballot to modify the structure and requirements to be as similar as possible to the E10 and E18 standards.

ASTM A833 (Comparative Brinell – Telebrineller)

A833 is a comparison method for an indentation on a reference bar against the indentation on the test surface. The ratio of the indentations provides a measure of hardness. This method is generally considered to be less accurate than those of E110 and E10.

ASTM A1038 (UCI – Ultrasonic Contact Impedance)

UCI instruments use a calibrated rod with a diamond indenter (typically a Vickers indenter) attached to one end. The rod is vibrated to a resonance frequency in the ultrasonic range and then pressed into the test surface with a pre-defined force (usually Vickers forces). The instrument measures the shift in harmonic frequency that varies according to the depth of penetration. This frequency shift is converted and displayed directly into a common hardness scale like Rockwell, Brinell or Vickers.

This method is very much affected by the actual material properties due to be tested, therefore a calibration must be carried out on a sample of the same material prior to testing, because of this we cannot use the concept of material groups like the Leeb method, due to the relationship between the frequency shift and the common hardness scales which is immensely material-dependent.

DIN 50156 (Leeb)

Although this is not an ASTM standard, the DIN 50156 standard for Leeb testing is also useful for ASTM conventions. This German standard is a national standard that includes traceable calibrations of test blocks and instruments to a national Leeb etalon. Calibrations are carried out according to ISO 17025 accredited organizations in Germany whose Leeb calibrated instruments are traceable to the German national laboratory (PTB). UKAS (United Kingdom Accreditation Service) calibration of Leeb reference test blocks is also available.

Conclusions

In an ideal world the inspection results should be stated in Leeb hardness scale. Additional traceability of calibration to a national Leeb test house can be granted according to DIN 50156. If conversions to other hardness scales are required, testing on reference samples is strongly recommended to verify the accuracy of the conversion. These reference measurements can then be used to reach intercompany / interlaboratory agreement on the testing procedures and inspection records.