


Technical Information

# Equotip Surface Roughness Requirements for Accurate Hardness Measurements

**How much surface preparation is required to achieve correct and reproducible hardness measurement values? Proceq evaluated measurements taken with Equotip 3 impact devices under varying surface roughness conditions, to provide a guideline for obtaining the best results with respect to accuracy and reproducibility.**

## Sample Preparation

The surface of a Mn-Cr-V tool steel was prepared using grinding paper of grit sizes P40, P80, P120, P150, P180, and P240. After each grinding step, the surface roughness $R_a$ was measured using a commercially available surface roughness tester. The hardness measurements were taken with Proceq's Equotip 3 impact devices types G, D, and C, as well as with Proceq's Equostat R5.

## Results

The graphs 1 to 4 convey three important messages from the experiments:

- Amongst the dynamic Equotip hardness testers, measurements done with impact device G are least affected by rougher surfaces. This is due to the higher impact energy and larger ball indenter radius of impact device G (90 Nmm, 5 mm) compared to the D device (11 Nmm, 3mm) and C device (3 Nmm, 3mm), respectively. On rough surfaces, the indenter of the C device in particular, only impinges on surface irregularities giving a low hardness measurement which is not representative of the material. Also for the Equostat R5, the susceptibility to erroneous hardness readings due to surface roughness is less significant than for Equotip D and C devices. The Equostat determines the hardness according to the Rockwell principle while using a lower load of 50 N.
- The scatter of hardness readings taken with impact devices D and especially C increases quickly with rougher surfaces. It can be seen that this effect is much less in the data recorded for the G and the Equostat devices.

- For the given steel surface, impact device G yields reasonably reliable hardness values after surface preparation with a P80 grit grinding paper. In the case of Equostat and impact device type D, it is recommended to obtain, at least, a P120 grit surface finish. With impact device C it is possible to achieve higher precision results on smaller and thinner samples than with devices D and G, however, the greater demands on the surface finish are greater, (P180 grit).
  Note: The presented degrees of surface preparation should be considered as a guideline only. Particularly in the case of softer metals, grinding with finer grit sandpaper may be required.

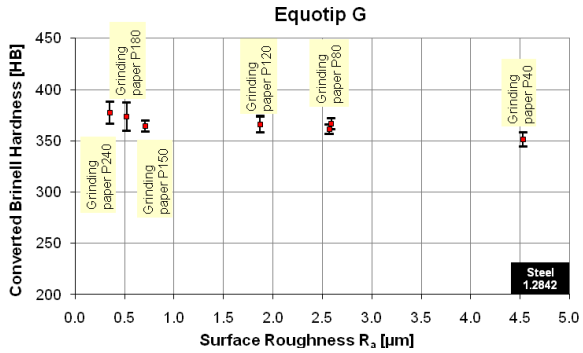


**Figure 1:** Brinell hardness *vs.* surface roughness obtained using an Equotip 3 impact device G

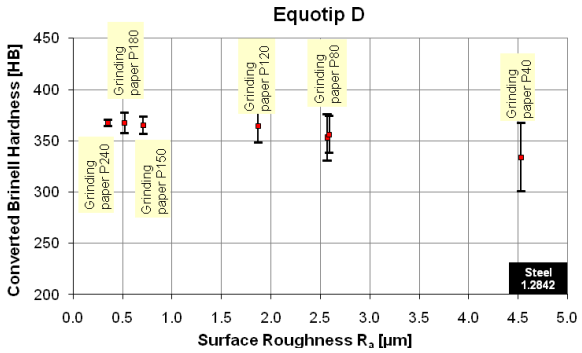


**Figure 2:** Brinell hardness vs. surface roughness obtained using an Equotip 3 impact device D

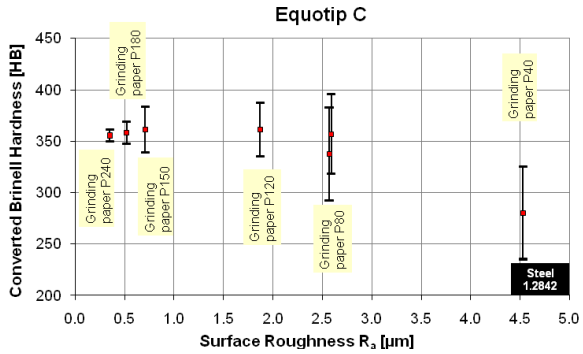


**Figure 3:** Brinell hardness vs. surface roughness obtained using Equotip 3 impact device C

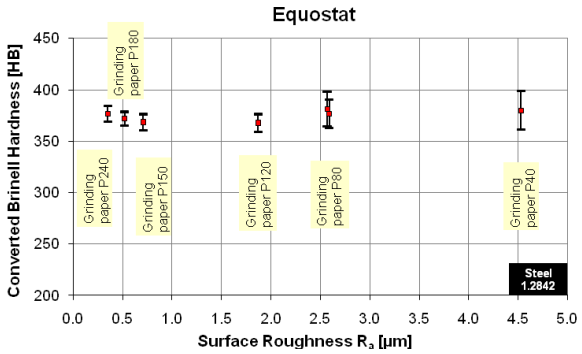


**Figure 4:** Brinell hardness vs.surface roughness obtained using Equostat R5

## Further Provisions

- In order to overcome the increased uncertainties of the results due to scatter on rough surfaces, the number of readings should be increased, along with the selection of the most suitable impact device.
- In case the readings deviate systematically from the actual sample hardness, the bias may be accounted for through a user-specific conversion (e.g. an offset). This is possible in most Equotip instruments. The individual bias correction needs to be worked out through measurements on two samples (one rough, one smooth) that have the same hardness,.

## Summary

Depending on the test application, different hardness tests and probes can be used. The selection of the right instrument shall be related, amongst other things, to the surface preparation. As a general rule for hardness tests: the better the surface condition, the more accurate and reproducible the measurement results. During surface preparation, however, it is critical not to alter the hardness through hot or cold working. In case surface conditioning has to be limited for economic reasons, utilities such as user-specific conversions or adaptations of the testing procedure should be considered.