

# Hardness testing on thermowells to prove their NACE hardness values

WIKA data sheet IN 00.43

## General information

Special material requirements for sour gas applications are widely used in the oil and gas and also petrochemical industries. These include, among others, a hardness limitation for the components used.

The hardness values of the primary material used are generally confirmed by the 3.1 acceptance test certificates in accordance with EN 10204.

For more detailed information, see Technical information IN 00.21.



Thermowells in different versions

## Description

The proof of the maximum hardness values in Rockwell C (HRC), required by NACE MR 0175 (ISO 15156-3) and MR 0103, is not trivial, since thermowells are mainly manufactured from stainless steels such as 316L or special materials such as Alloy 400. Thermowells, due to their geometry, often cannot be tested on a stationary Rockwell hardness tester, so portable hardness testing machines must then be used.

These work through the UCI method (Ultrasonic Contact Impedance). The test impression of a Vickers diamond is measured electronically and the values are output directly in HV (Vickers) or converted to Brinell or Rockwell.

Generally, several measurements are carried out per test and the average value taken.



Stationary Rockwell hardness tester (example)  
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Portable hardness tester

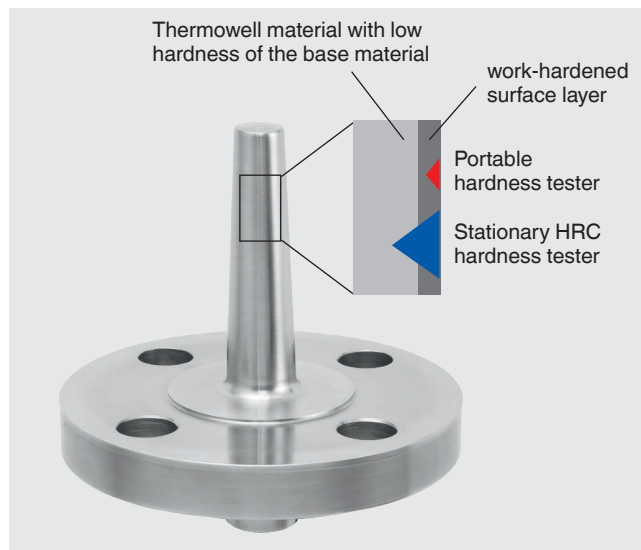
## Falsification of the measured values through work-hardening

The machining of the thermowells results in the effect of work-hardening the surface layer of the material.

Depending on the test methods and test force used, the respective methods measure at different penetration depths. Thus they deliver different hardness values.

- Many portable hardness testers operate with low test loads. These do not penetrate through the work-hardened surface layer and do not deliver a hardness value that can be compared with Rockwell.
- A stationary Rockwell hardness test rig, due to higher test loads, penetrates through the work-hardened surface layer and thus measures the hardness of the softer base material.

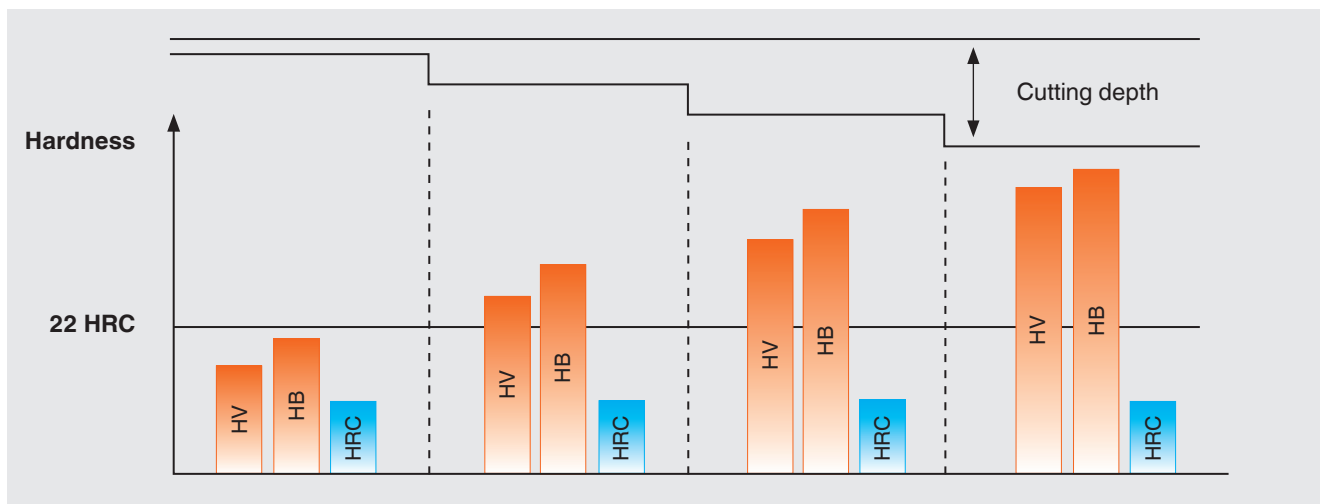
### Illustration of the surface layer principle



In cooperation with TÜV Hessen, WIKA has carried out numerous test series to obtain hardness comparison measurements between the Rockwell, Brinell and Vickers test methods with different test loads on a special stepped-profile test specimen with work-hardened surface layer.

The measured values have shown that it is not possible to compare the hardness readings of a portable measuring instrument (Brinell or Vickers) with those of a stationary Rockwell hardness tester. While the hardness values from the portable measuring instrument increase with rising cutting depth, the Rockwell hardness values of the stationary measuring device are almost constant.

### Schematic representation of the influence of the cutting depth on the measured hardness values



The maximum permissible hardness values are material-dependent. These correspond to the application of the respectively applicable regulation e.g. NACE MR 01/75 or NACE MR 01/03.

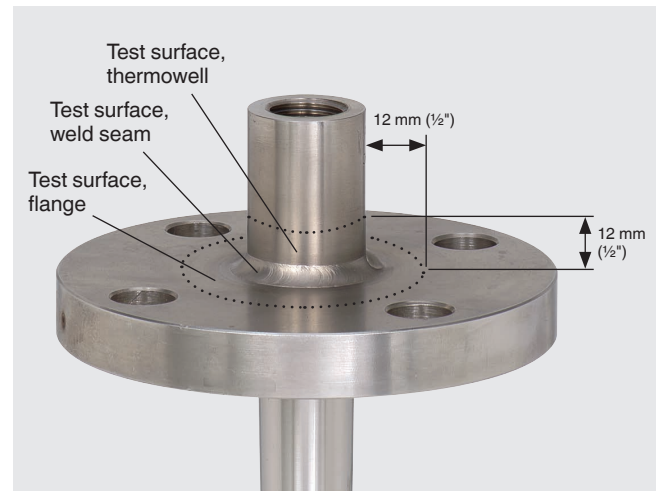
## Hardness testing for thermowells with welded flanges

The surface of a welded flange thermowell consists either of work-hardened or solution-annealed zones. Thus, the base material, through the manufacturing process, has been brought to a state in which, in accordance with the strictest specifications, a hardness test in accordance with NACE is no longer possible. WIKA has therefore decided to ensure NACE conformity through the sub-supplier certificate and, optionally, through a hardness measurement in accordance with this technical information in the heat-affected zone (HAZ) next to the weld seam.

In addition, this will prove that there has been no hardening of the materials due to the welding.

The proof of suitability in accordance with NACE MR 0175 (ISO 15156-3) and MR 0103 is provided through the measurement in the HAZ.

### Testing range, flanged thermowell



## Hardness testing for screw-in or weld-in thermowells

The hardness testing is carried out in an area of the thermowell with the lowest possible cutting depth.

A reliable statement about the core hardness of the material cannot be made by a test with a portable tester.

However, the use of stationary test equipment is also problematic here, since, due to the very high test loads, a secure support surface for the thermowell is rarely available.

### Hardness testing on a screw-in thermowell with a portable hardness tester



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