HEAT TREATMENT
OF METALS
tips for testers

Practical Steps in Rockwell Hardness Testing

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HOW TO OBTAIN CONSISTENT RESULTS

The modern Rockwell hardness tester is a remarkably dependable and versatile machine. It will sustain calibrated accuracies for an exceptionally long life in working conditions anathema to other precision instruments. When faults or errors do occur, they can often be traced, not to the machine itself, but to the way in which it has been operated. This article aims to help the competent operator obtain repeatedly consistent test results from a properly-serviced machine.

Initial preparation

Before starting a test run, make sure the machine is located in a position where little or no vibration is present.

Machines are often situated in environments that are none too clean. So the anvil, anvil seating and indenter seating should be cleaned with a grease-free solvent and dried with a lint-free cloth. These areas should be kept clean all the time the machine is working. If a cover is available, it should be fitted when the tester is not in use.

The three most common sources of test error are the test block, indenter and support anvil.

Clean test block

The test block has its hardness number etched on the side. It will usually be accompanied by support documentation. NAMAS-calibrated blocks are available for most popular Rockwell scales.

Choose a block whose hardness is within, say, five points of the hardness of the specimen to be tested. Clean the block thoroughly, paying particular attention to the bottom support surface, which must be squeaky clean and free from nicks and bruises. If you rub the block over the anvil, you can find out how good the surface is. It should almost "ring" to the anvil surface. If there is any doubt, a careful rub with a very fine emery over a surface plate should remove irregularities. That is why hardness tests should never be made on the bottom surface of a test block.

Check indenter

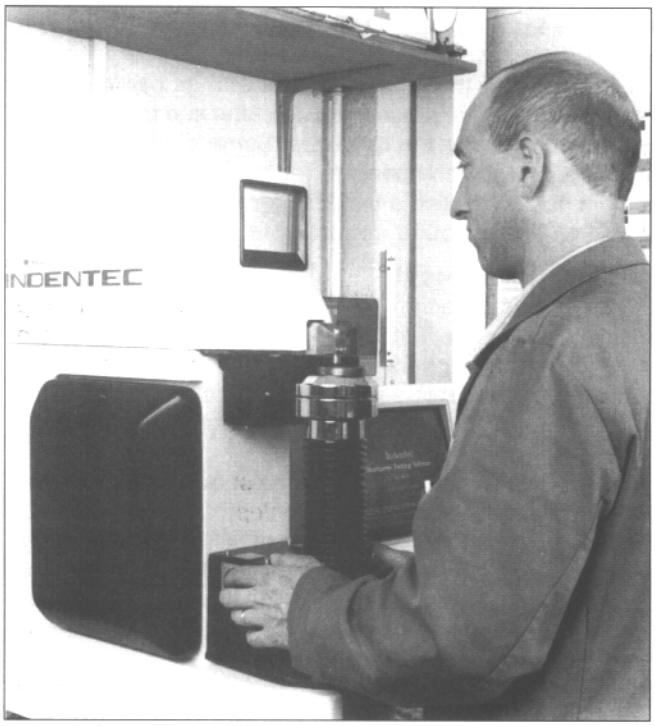
Incorrect Rockwell readings can also be caused by a damaged indenter. A flattened ball gives high results, and a chipped diamond can give either low or high results. Always change a doubtful indenter.

With a ball indenter this merely entails changing the ball, so it makes sense to keep a good supply of new balls in stock. With a diamond indenter, it is more difficult to see damage, even with a low-powered eye glass. The only certain way to double-check is to use a new indenter, one of which should always be available.

A faulty diamond indenter should be returned immediately to the maker for relapping. Put it on one side, and you will probably try to use it again later, when the fault has been forgotten.

Unmoveable support

In Rockwell testing, the results will only be as good as the method used for supporting the specimen. It must eliminate the slightest downward movement of the part during the test. Just two microns of movement (80 millionths of an inch) will produce an error of one Rockwell division.



Modern digital Rockwell testing machines, like this standardising machine, have an automatic loading cycle.

Here again, cleanliness is important. Make sure that the support surface, specimen undersurface and top of the leadscrew are clean and free from nicks and bruises.

Use a flat anvil large enough to prevent overbalancing for flat specimens, and a spot anvil for curved specimens, with the specimen curve facing upwards. A vee anvil should be employed for round specimens.

Checking the machine

Before starting the test, check that the correct test load and indenter have been selected for the scale required.

Be careful not to mix the wrong pre-load and additional load on some combined Rockwell and Rockwell superficial scales. All superficial tests use a 3kgf pre-load and all regular tests a 10kgf pre-load.

To bed in the leadscrew and support anvil, make one or two preliminary indentations but ignore the results. Now make two or three indentations for real, record the results and work out the average. You should compare this with the test-block calibration and check that it is within the BS tolerances allowed for daily monitoring. Do note that these tolerances are larger than those permitted on recalibration by accredited service engineers.

Never position indentations too closely together. Ideally, they should be 2mm apart with the diamond indenter and 4mm with the ball indenter. Modern digital machines have an automatic loading cycle. However, there are still several analogue manually-loading testers in use. If yours is one of

these, you must ensure that the total load is fully applied for two to three seconds. Always remove the load smoothly when operating the handlever mechanism.
Dial-gauge testers can have up to three graduated scales generally coloured black, red and green. Read off the black scale with diamond indenters and off the red scale with ball indenters, irrespective of ball size. Always zero on the black scale.
Rockwell superficial tests should be read from the green scale, with either a ball or diamond indenter.

Curvature correction
When cylindrical specimens are tested, the curved surface will influence readings. An external curve will give a low result and an internal curve a high one.
The diameter of the part under test and its hardness will affect the result. The smaller the diameter and the softer the surface, the greater the influence. Some digital machines will automatically compensate for both these variables. If you are not using such a tester, you must make a 'manual' correction from a 'round' correction table.

Minimum thickness
Be sure to select the right test load when testing a thin strip or a thin case depth. If the load is too high, the indenter can start to break through the case, resulting in low results. On thin strip, the underside will show a 'witness' bulge if the load is too high. This can produce both low and high readings.
The case depth or material thickness should be at least ten times greater than the indentation depth. A case-hardened specimen with a nominal hardness of 60HRC should have a case depth not less than 1 mm. If in doubt, check the part on the HRA scale using a 60kg load. The depth of indentation will be approximately halved, allowing a part with a case depth of $^1/_2$ mm to be tested effectively.
The Rockwell superficial test, which uses the same procedure and indenters as the regular Rockwell test, was developed to ensure that thin specimens and thin case depths can be effectively tested. The lightest superficial load, 15kgf, enables a component with an equivalent hardness of 60HRC to be tested on a case depth as little as 0.15mm.
It is important to be aware of this test because a machine without a Rockwell superficial facility may produce low readings because of high test loads. There may be nothing wrong with the heat treatment.

Conversions to other scales
There are well-established conversions between all hardness scales, Rockwell, Vickers and Brinell, and they can provide a useful guide. However, care should be exercised, particularly when testing aluminium, softer alloys and stainless steels. Ask your testing-machine manufacturer to provide a wall chart, which should include a conversion table.

Any make or type
Although the market nowadays contains many different makes of Rockwell-type testing machines, they should all meet basic criteria in performance and operation. As long as your machine is regularly maintained by a competent service organisation, you should be able to attain a high standard of accurate cost-effective testing if you follow the essential procedures outlined in this article.

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