KNIFE GRINDERS KG

www.knifeGrinders.com.au
KG@knifegrinders.com.au
Australia

By Vadim Kraichuk

Effect of Hardness on Edge Retention

Thanks to BESS and EdgeOnUp we've got samples of A2 tool steel hardened differently.
A2 is a high carbon, high molybdenum tool steel.
The A2 blade #7 has been hardened to HRC 54, while the A2 blade #11 to HRC 62 - they represent extremes of the common knife hardness range.

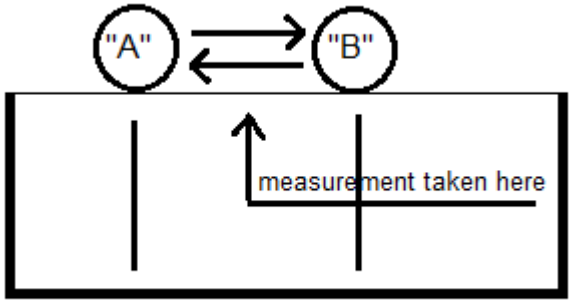
We sharpened these two blades exactly the same way at 15 degrees per side (dps) on Tormek using CBN wheels, the edge set on CBN #1000 edge-leading. Deburring was done on a paper wheel with 5 micron diamonds with the help of our support for controlled-angle honing and computer software.

The initial sharpness was very close, 109 and 114 BESS (very sharp).

Copyright Knife Grinders 2018

The 2 blades have been subjected to controlled edge rolling on the BESS SET tester.

Rolling cycle explained
The impact roller is a linear bearing slant at 10° to the horizontal base or in other words at 80° to the plane of the blade clamped vertically.
Standard impact assembly weight is 150 grams.
The impact roller is lowered at "A", then moved (rolled) over to "B" and then back to "A".
A-B-A is one cycle.



See our video on YouTube https://youtu.be/EdGOSWjrM0E

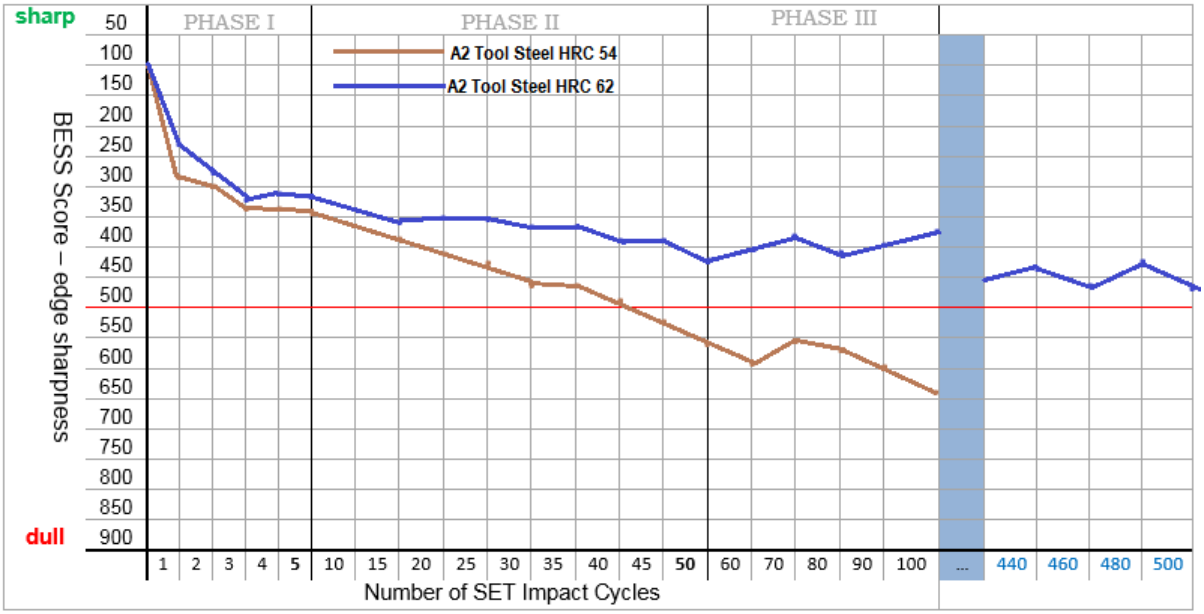
The results have shown a tremendous difference in edge holding.

It took 45 rolling cycles to blunt the HRC-54 blade to 500+ BESS. (Sharpness score over 500 BESS indicates a dull edge.)

The HRC-62 blade holds a working sharp edge at least 10 times longer.
I say "at least" because even after 500 rolling cycles the HRC-62 kept scoring a working edge of under 500 BESS. By then I had been rolling the HRC-62 for 1 hour, and just gave up on blunting it.
For comparison, mainstream knives blunt to 500+ BESS within the first 100 rolling cycles.

Copyright Knife Grinders 2018

Chart



However, despite that extraordinary edge holding, the HRC-62 blade won't hold the super-sharp edge any better.
The initial blunting rate is relatively rapid regardless of hardness.
Initially both blades were scary sharp near 100 BESS, but it took only 1 rolling cycle to blunt them to just sharp, and 5 rolling cycles to working edge.
The divergence of sharpness graphs in the chart starts at about 350-400 BESS - the HRC-62 sharpness stays at this level through continued rolling impacts, while the HRC-54 sharpness deteriorates almost linearly till blunted to practically unusable.
400 BESS is what real world working edges score, and the A2 @ HRC62 holds this edge extremely well - we've seen that good edge retention only in Vanadis-10 and ceramic knives.

Key Indicators

Key indicators	**HRC 52**	**HRC 64**
Average of sharpness scores in the first 5 impact cycles (Phase I - elastic deformation)	319	291
Average of 3 sharpness scores: after 40, 45 and 50 impact cycles (Phase II - elasto-plastic transition)	527	388
Overall average sharpness over 100 impact cycles	460	356
Number of impact cycles to turn the edge blunt at 500 BESS	45	Over 500

Steel hardness is related to its compressive yield strength which tells us the stress at which steel begins to deform plastically.
A2 steel hardened to 62 HRC has compressive yield strength some 320 ksi while the same steel hardened to 54 HRC has compressive yield strength only some 250 ksi.

For the blade hardened to 62 HRC the stress generated by the SET roller is slightly below the compressive yield strength, and thanks to elasticity the blade shows resilience to rolling.

While for the blade hardened to 54 HRC the stress generated by the SET roller is slightly above the compressive yield strength and some fraction of the deformation remains permanent. This permanent edge deformation cumulates and causes the observed sharpness deterioration as the plastic deformation grows.

Copyright Knife Grinders 2018

Raw Data

Data numbers in the charts is the number of the impact roller cycles with the resulting sharpness. E.g. " *x1 = 150, x2 = 300* " means after 1 impact cycle the edge sharpness is 150 BESS, after 2 cycles 300 BESS, and so on.

A2 Tool Steel Sample →	**HRC 54**	**HRC 62**
Initial Sharpness BESS	109	114
SHARPNESS BESS	x1=282 x2=300 x3=334 x4=332 x5=349 x15=384 x20=410 x25=428 x30=464 x35=467 x40=496 x45=526 x50=559 x60=593 x70=551 x80=567 x90=599 x100=637	x1=235 x2=278 x3=320 x4=307 x5=314 x15=356 x20=351 x25=352 x30=366 x35=365 x40=390 x45=393 x50=421 x60=402 x70=383 x80=406 x90=399 x100=376 x110=444 x120=474 x130=433 x140=442 x150=438 x160=436 x170=464 x180=400 x190=426 x200=452 x220=438 x240=460 x260=435 x280=428 x300=453 x320=441 x340=461 x360=487 x380=486 x400=457 x420=466 x440=441 x460=455 x480=426 x500=468 …

Copyright Knife Grinders 2018