CPM 4V

I recently got a bar of CPM 4V and gave it a try for a blade and here are the preliminary results based on one knife.

Back Ground
I am always striving for maximum edge holding on abrasive materials since most of those I make knives for are hunters and fisherman. Field work on dressing game animals and most larger salt water fish will very quickly degrade a blade. I grind to a thin edge behind the sharpening bevel so hardness and resultant strength are important to minimize edge deformation . I don't worry too much about impact toughness since these knives are designed for slicing and not chopping. Corrosion resistance can be a factor depending on maintenance and environmental conditions but is secondary to edge holding and strength. Normally I would select one of the A11(non stainless high vanadium tool steel) or like grades for this application. They have always been the datum to which I compare performance. However, they are more difficult to grind and finish and if an intermediate medium carbide grade can provide good performance and require less consumed small materials and abrasives and time, then it is well worth considering. CPM 3V has the workability qualities and amazing toughness (at RC 58) but the added alloy in CPM 4V has the potential for maximizing the wear resistance and edge holding that I am looking for. I used a South Fork trailing point for the test knife since I have several other SF's in various steel grades with the same geometry so subsequent comparisons can be made to CPM 4V.

Heat treat objective
Quench rapidly enough to end up with maximum martensite and minimize retained austenite
Utilize a cryogenic cycle to reduce retained austenite
Temper to resolve remaining austenite not transformed in the deep cooling cycle and reduce stresses.
Temper to take advantage of secondary hardening and generate precipitated secondary carbides for added wear resistance
Temper again to relieve stress caused by the secondary carbide precipitation
Temper again to relieve mechanical stress caused by grinding.

Heat treat results
Wrap in high temperature foil
Insert at 1550 and ramp to 2040, hold for 20 minutes
Forced air or plate quench to room temperature, AQ = 65 RC
Direct into LN2 and hold overnight (24hours) RC 65
Temper 1 at 1000 for 1 hr, RC 64.5
Temper 2, at 1000, for 2 hr, RC 64
Temper 3 at 1020-1030,for 2 hr, RC 63/63.5
Finish grind and Temper 4 at 980 for 1 hr to remove grinding stresses , RC 63/63.5 final hardness

Testing
To test edge holding I cut ¾ inch manila rope with a sawing motion back and forth. Cutting is only on the 1 inch length of the curved belly in order to focus the wear. It takes 7 strokes to cut through with moderate down force. The knife blade is .008 behind the cutting bevel and was sharpened with a 600 grit diamond plate at 30 degrees included angle. A couple of back strokes on a loaded strop are used to remove any burr and refine the edge. At this point the knife will cleanly cut news print and shave fine hair against my arm. As cutting progresses I am looking for the point where the edge starts to smooth out and start to lose some bite. I measure this with my “educated thumb” but is the point where the knife will clean cut printer paper but tends to snag a bit on news print paper. The blade is still sharp

enough to skiv leather and easily whittle and shave curls off wood. There was no visible edge damage from the rope cutting. The knife was re-sharpened with 5 strokes per side on the diamond plate. This knife is very easy to sharpen due to the high wear resistance since very little material needs to be removed to restore the edge.
The knife did 60 X 7 cuts on the rope. I consider anything over 40 to be very good performance and will be adequate for field dressing, quartering, and boning out a mule deer before it looses the bite. For comparison CPM 10V at RC 64 on this rope will cut about 100 slices with the same geometry and sharpening.
I tested toughness and edge strength by aggressive whittling on seasoned fir. It shaved nicely and there was no edge deformation or chipping with about 40 lbs force pushing thorough the cut. I next cut Bocote, a very hard tropical hardwood and did get some visible deformation and some light chipping. This is normal for this blade geometry and hardness since with this very hard wood it is easy to exceed the maximum stress on the edge. See toughness definition below.

This is a first try on the heat treat and I used close to the maximum recommended austenitizing temperature. I consider the resultant toughness to be fine for my use criteria. It is interesting to note that acording to the data sheet at similar hardness (62) that CPM 4V (36 ft/lbs) is only about 10% less on impact toughness than CPM 3V (40 ft/lbs) . I think that this is a small price to pay for the additional wear resistance. The steel grinds nice and takes a good 220 grit belt finish. It was very clean and no inclusions were noted. This is a nice medium grade alloy that has performance between some of the lower alloy grades and the high percentage high Vanadium grades like the A11's. I think it will fit right in with many makers looking for high performance on abrasive materials.

Note: The data sheet says not to temper below 1000 F.
The accuracy on the rope cutting is about +/- 10 slices.
Others with a different test methods may get different results and they will be dependent on heat treating, edge geometry, sharpening method and ergonomics of the overall knife. This is one knife, one test, with an initial heat treat. I pass this information on hoping it will be useful for others as a place to start on this steel grade.

Toughness
There are different understandings of what toughness means. As it applies to a knife blade I am looking for an edge that has enough elasticity to flex back and forth while cutting hard and abrasive materials. If pushed past the elastic limit it should bend (yield) a bit before breaking (ductility). Impact toughness is different and is the ability to take sudden dynamic forces and not yield or fracture. This is measured by the Charpy test and is what is referenced on data sheets as “toughness”. Strength is the ability or stiffness to resist movement of the blade edge. Tensile strength resists stretching or pulling apart of the material and compression strength resists deformation or denting. As hardness increases, strength increases in tandem.

Phil Wilson
seamountknifeworks.com