A Different Approach to Decarb Protection

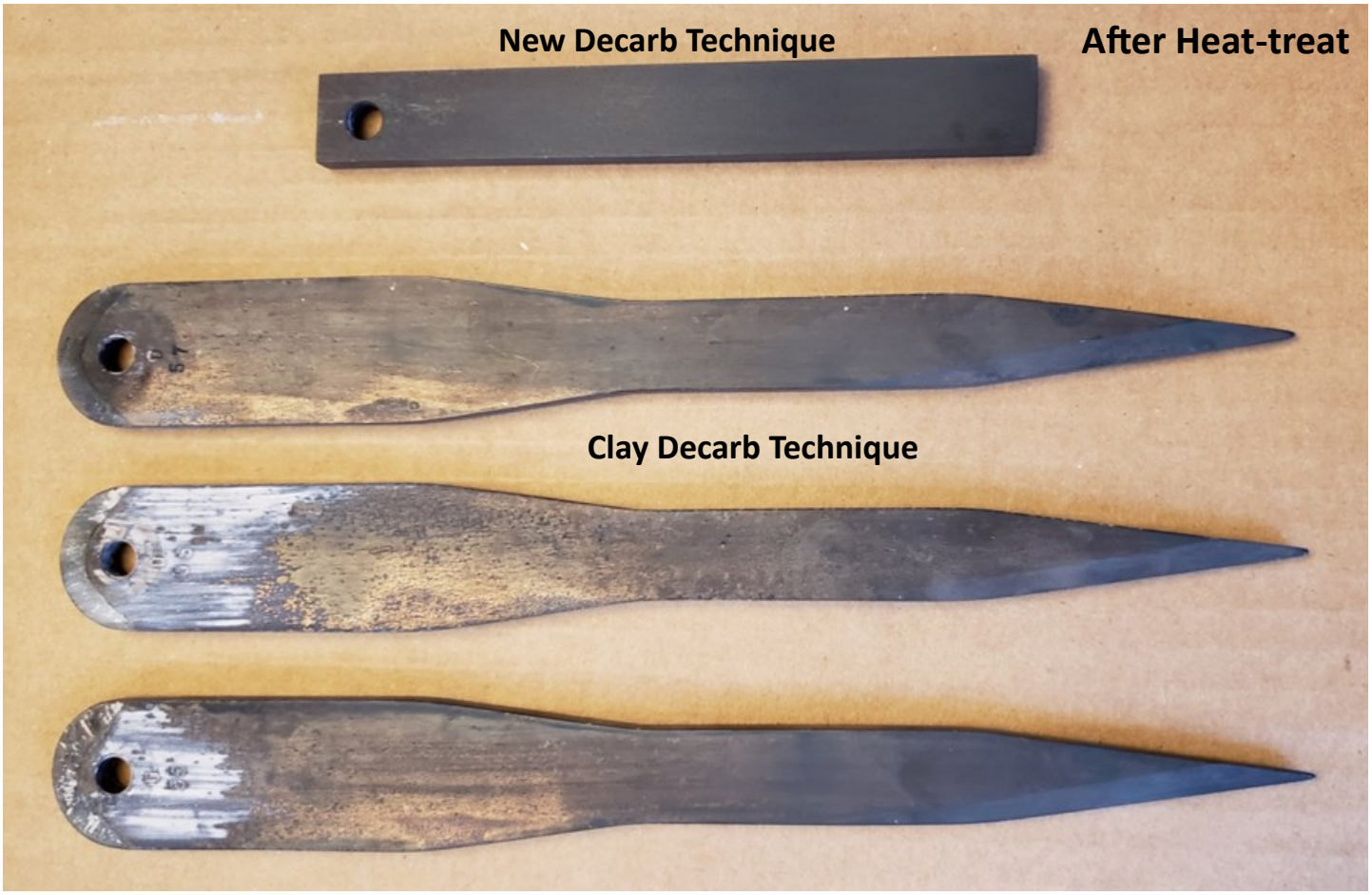
Since we started making our own knives, we have dealt with issues of decarb and decarb protection. We originally used a powder from Brownell that I bought over 40 years ago for gun work. It worked well! Just heat the metal to 500° F and sprinkle onto the surface. A breathing mask was a good idea when applying.

The powder came off easily when the knives were boiled. This made the final step of clean-up fairly easy—use a buffing wheel to remove any excess while eliminating the blue color from tempering at 750° F. We still continued to research other approaches.

The next step was clay that we would apply in a thin layer with a brush. This was a bit easier, since there was no requirement to pre-heat before application. The cleaning process required using a dilute solution of the clay to abrade the piece before applying a thin layer. It worked fairly well. The Darts below were treated with it before heat-treating. The main issue was a the residue that flaked off in the quench oil. This required occasional cleaning of the quench oil. There was also a small amount of scale and decarb that had to be belt-sanded to remove before hardness testing. Still, it worked pretty well. It also caused me to look further in the name of zero residue, zero scale and zero decarb, even minor decarb.

Lately, after searching online and coming up with nothing new, I began to consider a new approach for de-carb and scale protection. My goal was an approach that was simple, easy, cheap and as previously stated, zero residue to filter out of the quench oil and zero decarb/scale. It appears that I have found it!

Notice the test piece (short, black piece) below. I heat-treated it with the three Darts shown next to it. It appears to have a smooth, dark finish, no decarb or scale, compared to the Darts. It does!



Comparing the New Decarb Protection to Clay

In order to determine the performance of our new decarb approach, I first used a buffing wheel with 150 grit. This was our clean-up approach when we used the decarb powder. Since the powder could be removed by boiling in water, all we had left to buff away was the blue color from tempering.

Although the clay required more than just buffing, I wanted to compare the test piece to the Darts as far as finish. As you can see below , there is some truly minor scaling on the Darts, but none of the test piece. The buffing wheel just removed some of the thin protective layer.

Comparing the New Decarb Protection to Clay (cont.)

The next step was the belt sander, using a 220 grit belt. We typically use a 120 grit belt to clean up the Darts after heat-treating when using the decarb clay. Since I knew that the 120 grit would eliminate any visual signs of decarb or scale, I decided to use the 220 grit belt in order to continue comparing the test piece to the Darts.

The Darts now look pretty good and a Garnet blasting would be all that is needed to finish them. The test piece looks like it did before I ever applied the decarb protection.

What was more impressive was the hardness tests. The test piece had an **HRC of 51**. The five averaged hits were also very close in value. In the past, I had to remove a fair amount of metal to get these results. I knew I was on to something.

On the other hand, the Dart that I tested initially had an HRC of 47.2, which was not surprising due to an extremely shallow decarb layer that I must always remove when using powder or clay.

As I said, having seen this before, no matter which decarb protection I used—powder or clay, I assumed that there was most likely a really thin carbon depletion layer left on the Darts, so I hit the Dart with 120 grit and tested it again. The HRC of the same Dart changed to 48.6! Due to past experience I had no doubt that more belt-sanding would reveal greater surface hardness. But since it would also reduce overall thickness, I stopped. After all, I knew from previous testing , especially with the new quench system, that the Darts were tough! I just wanted a better, cheaper approach that also required less prep and clean-up.

You know what they say, "Laziness is the Father of invention!"

Let the Testing Begin

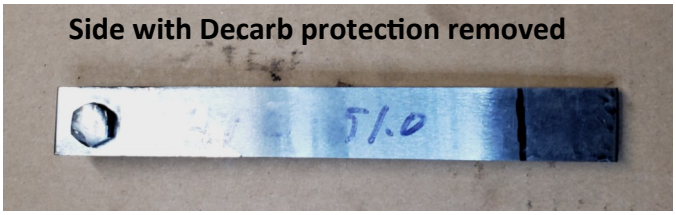
Before getting too excited about this new process, I first had to determine if there was any change in toughness. So, that meant 50 hits with the old 4 lb sledge. I didn't expect any problems, but we learned the hard way to test performance after any change in our approach to heat-treating.

This time I had to do it without help. An arduous task, to be sure. So I clamped the 6" piece in the vise at 1" (the black line on the cleaned side) from the bottom and proceeded to beat the crap out of it . After 50 hits, and a few misses, I removed it from the vise and measured that amount of deflection.

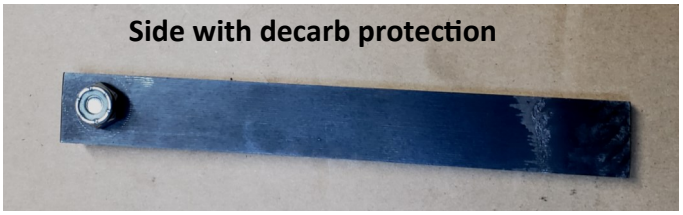
We have performed this test several times in the past to test various improvements to our process, but I was impressed when I measured only 2.4° of bend. The least amount of bend we've ever had! Previously with our new quench system the least we have had was 3.7° and the most was 6.0°.

My next test would be heat-treating a set of Darts. I was expecting similar results, but we do have our golden rule: **Never change any heat-treat process without testing!**

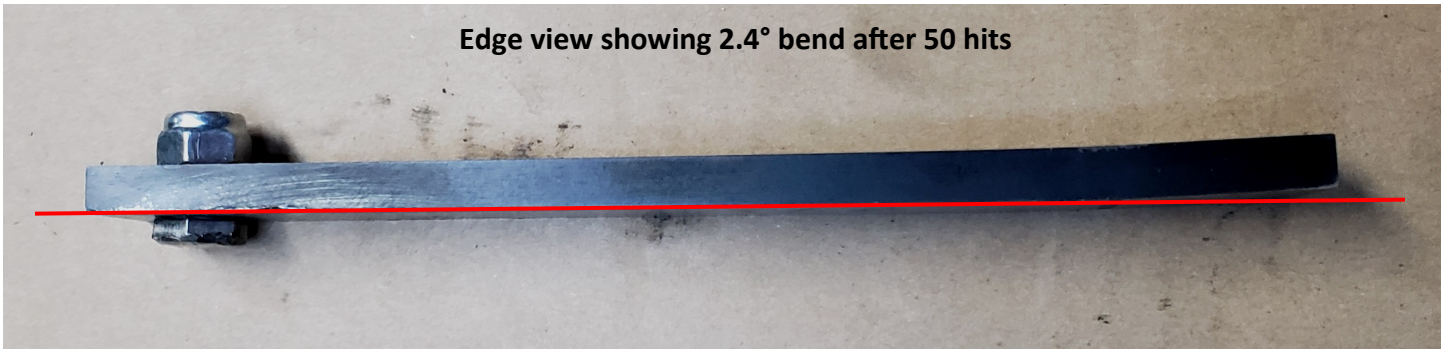
Side with Decarb protection removed



Side with decarb protection



Edge view showing 2.4° bend after 50 hits



The Darts treated with clay, after clean-up with 120 grit it's ready for garnet blasting

(They still look pretty good!)

More Testing of the New Approach: Heat-treating a Set of Darts

After verifying that there was no decarb or scale on the test piece, the next step was to determine how well this new approach worked with a set of Darts. So, let's go through the steps, after making them the usual way:

Step 1. Clean (I use lacquer thinner) and attach wires for hanging.

Step 2. Spray a light base coat of decarb, followed by 1 or 2 coats and allow to dry for ~ 20—30 minutes.

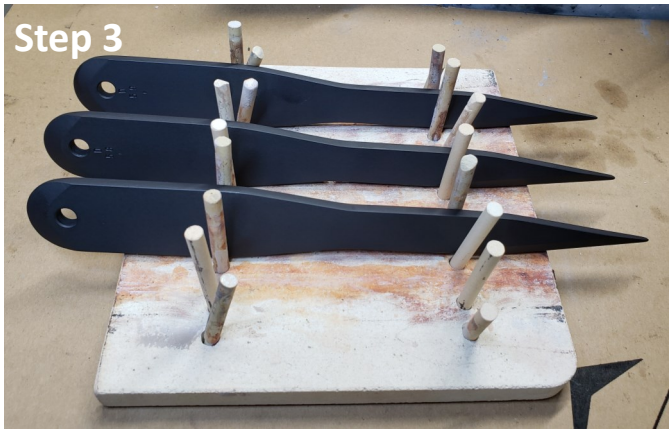
Step 3. Remove wire hangers and place on ceramic carrier for insertion into the furnace.

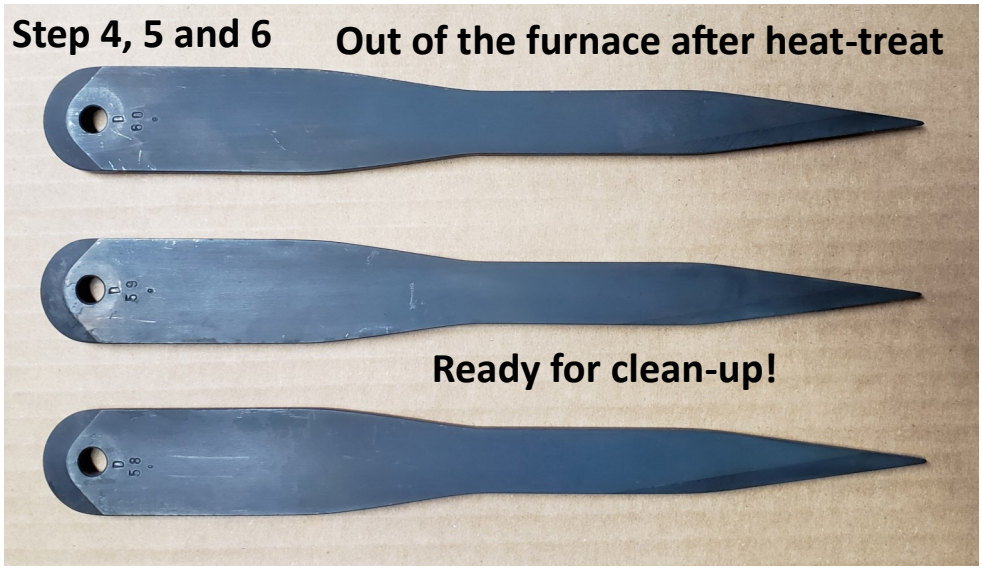
Step 4. Perform heat-treat. I use O1 tool steel, so I slowly bring up to 1460° F, hold for 15 minutes and quench. I then place pieces in my oven @ 330° F and leave in for an hour while the furnace comes down to < 750° F.

Step 5. Place the Darts into the pre-heated furnace for two hours. Remove them, place them into water (rapid cooling), remove and dry them.

Step 6. Admire my work!

No sign of decarb or scale! Actually, no sign of exposed steel!





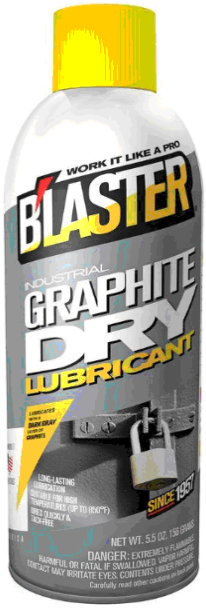
Close-up of a Dart, with a "G" stamped below the serial # I wonder what that could mean.

Summary

So now I know that this stuff works!!! I will probably stare at the POC (Proof of Concept) Darts for a while before testing them further, but eventually I will remove the thin film (not measurable with my micrometer) and use them or sell them.

I still have some testing to perform regarding possible use of propane. I plan to use a scrap piece, paint it and take a blow-torch to it to see if this stuff can withstand open flame. I have no idea, but I'm doubtful.

As far as I'm concerned, I will never use clay or powder again!!! This process provided a clean surface and appears to have suffered no loss in carbon content, as I usually have.



So, what is this amazing decarb approach? If you have read this far, or skipped to this page, your efforts are rewarded. I used a graphite (an allotrope* of carbon) spray, that I have used for years to lubricate firearms. It is cheap (about $5 at Home Depot or Amazon), simple to apply and so far, provides maximum protection against decarb and scaling relative to anything I have ever tried. There are probably many graphite sprays that will do the job, this is the one that I used in this experiment.

This is what I now know,

1. It works great on O1 tool steel.
2. It works great in an electric furnace.
3. It works better than any other technique that I have tried—powder and clay.
4. It is simple to apply! Just clean , I use lacquer thinner, spray a couple of even coats, allow it to dry (it's quick) and place in the furnace, turn on the heat.
5. One other thing that I learned was don't touch up the surface before placing in the furnace. I had a couple of spots that I scratched while taking pix of them right before placing in the furnace. My solution was to spray the spots then place them in the furnace. The result: the spots came off when quenched, becoming a residue that was filtered out of the closed cooling system. I could actually see where the spots were. The graphite seemed to be thinner at those spot, but unbroken. Graphite is slick stuff, literally! So, if you try this, just put it on, let it dry and don't worry about any minor surface scratches.

So, after testing, what I don't know is how well it works on other steels (higher hardening temps) and if it can provide protection when using a propane (Yuck!) forge for hardening. I will be testing that, but I wanted to get this paper out so others can try it. If anyone does try this stuff, please share your results.

Remember, this is for amateurs like us, who make knives by the removal process and perform their own heat-treat! The pros can send them off to be heat-treated by other, but where's the fun in that?

By the way, we are thinking of calling this process, "Bellagraph Approach" or "Bellashield"

Of course, we don't make the stuff, we just found a unique use for it!

*One of two or more existing forms of an element. I had to look it up!

Graphite is one of two crystalline allotropes of carbon. The other is diamond. Since decarb removes carbon from the surface of carbon steel, by definition, what better protection against decarb, than a layer of pure carbon.