Marquench & Satanite

Heat Treat starts with a blade ready for -- wait for it -- heat treating. You need to know the critical temperatures, soak times, tempering temperature, etc. Luckily, almost all high carbon steels have very similar characteristics vis-à-vis the heat treat. The blade shown here is 5160 and has been ground down to 150 grit. It's ready to become a knife.

Since the critical temperature (~1550 F) is well in the scaling range, you can expect scale unless you are using a noble gas atmosphere or hot salt. Since we are not, what we will use is a coating that keeps the oxygen off the blade. The first step is to thoroughly degrease the steel (any decent greaser like the ones shown here will suffice). Wash it until water sheets off the blade and then keep those grubby mitts off it there after.

What we will use is "Satanite" - a relatively inexpensive kiln wash that can be used for stabilizing Kaolwool & Inswool and is used for hamon formation. What we need is some Satanite (comes as a gray powder), some water, a bowl, a stir, and a cheap brush. We are not talking big bucks here. You mix a little water into a couple of tablespoons of Satanite. What you are looking for is a mixture that is maybe milk to cream viscosity. It is amazing how little water is needed, so go gently with the water. Use the "couple of drops, stir" repeat system.

Of course, there is a problem - how do you hold the blade without touching it while applying the coating? One solution is shown here - an old set of vise grips with two "extensions" and a matching socket in the vise. Clamp the blade, coat one side, then flip the vise grips over and do the other side. Of course, having an assistant on the ends of a pair of tongs works too.

You can wait for some time for the coating to dry or you can dig out the old heat gun. Fire it up and start drying the blade.

The Satanite conveniently changes color as it dries, so there isn't too much mystery in determining when on side is completed. Flip the blade over and finish off the back side and you are done. The coating is fragile, so be careful handling it. The blade is probably hot, too - so think tongs.

We now turn to the forge or austenizer to be used. This is Don Fogg's design. It is a 55-gallon drum with 1" of Inswool lining the interior. There is an access door in the front, a couple of vents in the rear, a port for the temperature probe, and a single venturi gas burner located centrally at the bottom of the unit. The basic concept is a very large volume heated by a single small source of heat. The burner is blows through a refractory brick and a stainless heat diffuser is positioned over the flame.

Because of the use of a venturi burner (as opposed to Don's design which uses a blown system), a tiny blower is needed. Without the blower, the pressure in the forge is sufficient to choke the burner. The blower is a 12V squirrel cage and plugs into the bell of the burner. The system needs only 3 to 5 psi to hover at 1550 F and reaches that temperature in about 15 minutes from light off.

The image shows what the system looks like when running. A word of caution - due to the internal pressure being higher than ambient pressure, you can lose your eyebrows by getting too close when peeking through the door (don't ask how I know).

A high temperature probe is inserted through the probe port which places the probe on level with the blade hangers (approximately central in the drum). The probe is a Type-K electrode talking to an Omega hand-held digital pyrometer. As seen here, the temperature is getting close to what is needed.

For this test, the blade was hung on a small stainless hook and that hook was hooked over the main blade support. In this image, you can see that the blade has reached critical temperature. From this experiment, the blade appears to reach critical in less than two minutes and the temperature in the forge may drop as much as 20 to 30 F when the door is open. This compares very favorably to the Paragon oven in which the temperature drops by 100 F or more. The recovery time is also much faster - in terms of a few minutes as opposed to a substantial fraction of an hour.

One of the prime questions to e answered by the experiment was whether the coating was tough enough to withstand the repeated handling necessary to heat-cycling the blade. As you can see here, the coating seems to be holding up just fine. The "black" are at the tip of the tang is the bare spot left by the jaws of the vise grips. It gets the usual three times to critical and air cool to black, then to critical a fourth time before quenching.

Since we are using 5160, we need an oil quench. What is shown here is a simple but effective system. It is a pipe welded to a very stable base (you DO NOT want a spill!) with handles left to right and a snuff lid. NEVER use an oil quench unless there is some way to snuff the tank and preferably, make sure that the lid is compatible with the tongs you are using. The pipe has to be of a sufficient diameter (3" or more) to prevent it turning into a Roman Candle generator. The oil simply needs to have a reasonable flash point - so no used motor oil!

This is what the blade looks like after the quench and after the swirling in the oil subsided. There is little evidence of failure in the coating, so it is looking pretty decent.

After cooling the blade and wire brushing off the coating, this is what we got. There is little to no evidence of scaling. Hardness is somewhere north of 55 Rockwell C (based on a set of testing files) but under 60, so it is a little softer than it could be, but it is still in an acceptable range.

The final step is tempering. As is typical, an old toaster oven is being pressed into service. Given the initial hardness, a temperature of 375 F was used and the blade was cooked for an hour. It's now time to do the finish grind and start on the fit-&-finish.