Making your own….

Turning Tools - Heat Treating

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Heat treating metals is a very complicated subject. Many MANY books have been written about it. Almost all of them differ in what they recommend. Even the same author will, over the course of different books, change what they recommend! There's been a whole lot of mis-understanding, guesses and just plain myths handed down over the eons concerning how to make a piece of steel hard or soft. My overall recommendation is this: When in doubt, have an experienced blacksmith or knifemaker do it for you or guide you in the process. Both making your own tools and using those tools in woodturning can be dangerous in many different ways. Keep this in mind

Remember, each type of metal is different. The colors and temperatures mentioned below are basic points of reference for Tool Steel in general. Your steel may need more or less heat and/or time than listed below. Experiment or get the reference books and some Tempil Sticks to be exact.

So, you know what you want to make and you have the steel you're going to use to make it. It's time to get it ready to make something with it. First, the steel needs to be soft enough to work it (relatively) easily. That's a process called ….

Annealing

Most Tool Steel that you buy commercially will already be annealed. If you don't know for sure, anneal it yourself. Heat the area of steel you need to grind, bend or otherwise work to a point where it's no longer magnetic. Let it cool to room temperature as slowly as you can. Ideally, sink the steel in some Vermiculite or something else to cool it no more than 20 degrees F per hour.

Now, it's soft enough to grind and do some light hammering or very light bending. But to really work it as in forming a hook in a hook tool, heat the area up to cherry red and start at it. Try not to overheat it! Work it until it's not red anymore and then heat it back up. Don't get it orange or yellow color! You could damage it.

Now you have it the shape and rough ground size you need it. Let's make it hard!

Hardening

Heat up the area you annealed before to a cherry red as quickly as you can. Keep adding the heat for another minute or so and then quench it in the appropriate quenchant quickly. Stir it around in the quenchant (*more on quenchants on the next page*). If you just let it sit (unless it's "air quench"), the immediate surrounding area will be hot and not cool the steel as quickly as possible. Cool to room temperature in the quenchant. Clean off the tool and inspect for cracks. Sometimes you get cracks. If you get any, cut that off and start from the beginning.

You can check for hardness by lightly drawing a standard file across the area. If the steel is hard enough, you shouldn't see any scratches or at least very very light ones and the file won't "dig in."

These are general recommendations for most types of Tool Steel. There's all sorts of steels and each have their own critical temperatures and heat treating properties. Use this as basic guide only.

The Basic Steps to Heat Treating

- **Anneal**—Softening of metal by heating iron-containing metals to just above the point where it becomes non-magnetic and then cooling very slowly.
- **Harden**—Heating the metal slightly above the point where it becomes non-magnetic and quickly quenching it in the proper quenchant for that metal.
- **Temper**—Heating the metal to it's tempering heat (light straw color) to lower it's brittleness and reduce stresses.

2000F	Bright yellow
1900F	Dark yellow
1800F	Orange yellow
1700F	Orange
1600F	Orange red
1500F	Bright red
1400F	Red
1300F	Medium red
1200F	Dull red
1100F	Slight red
1000F	Very slight red, mostly grey
0800F	Dark grey
0575F	Blue
0540F	Dark Purple
0520F	Purple
0500F	Brown/Purple
0480F	Brown
0465F	Dark Straw
0445F	Light Straw
0390F	Faint Straw

At this point, the steel will be so hard it is brittle. If you drop it, it'll likely shatter. This is just way too hard to be useful for a wood-turning tool. We'll need to slightly soften the steel. We don't necessarily have to soften the very edge of the cutting edge of the tool but we certainly need to soften the rest of what we just hardened.

That brings us to ….

Tempering

Fantastic guides and references include:

- Machinery's Handbook
- Edge of the Anvil by Jack Andrew
- ASM Metal Reference Book
- Http://AnvilFire.com

We're not going to go as far as annealing the steel to soften it. We're just going to back the hardness of a little bit so it's not brittle. This is VERY important for a woodturning tool. We don't want the tool just shattering or snapping off as we're turning. It's best to be safe and have the tool a little soft rather than too hard. It just means a bit more frequent sharpening. We can always re-heat treat it again to get it a little harder next time if need be.

During this process, you need to go very very slow when applying the heat this time. If we go too far, and it's soooo easy to do it, then you have to repeat the hardening step again. Go slow! Most people tend to just use a torch or gentle flame for this process but you could also use the little trick of heating up a thick flat piece of steel to the temperature you need and placing the tool on that steel. The tool steel will absorb the heat from the other steel slowly and only as much as is needed until both are the same temperature. While this method takes awhile, it's safe. For most steels, especially good high-carbon tool steels, a kitchen oven doesn't have a high enough temperature setting or keeps it even enough to work very well here.

You can use Tempil Sticks or other temperature sensitive markers to know when you've reached the right temperature or you can just rely on the colors that the steel turns when a certain color is reached naturally. Remember, all steels are different and different colors don't means exactly the same temperature for each steel. But it's close enough for us, usually. To really see the colors change on the steel well, we need to clean off the steel from the Hardening process. It doesn't have to be polished but we do need to see raw steel. Use some sandpaper, going up to around 200 grit, to clean off the tool and get to bare steel.

If using a torch or gentle flame, carefully heat the tool steel away from the thin cutting edge. You may need to just pass the steel over the torch a few times if the steel is thin. You're heating the larger mass first and when it heats up, the heat will move on it's own to the edge quite quickly. As soon as you see a light straw (kind of a pale dull yellow) color heading for the edge, quickly quench the steel. Quenching, as a rule, is not what you want to do in tempering but for this method it's about the only way you can keep the edge from going to a brown or blue color and going too far. With other, more gentle and slower methods (as described above), there's no need to quench as there's no chance of going too far.

Hey! That's it. It's time to really clean the tool off, polish it, and do any final sharpening. Try it out on the lathe!

*** A** forge makes things go faster but a torch will work for small areas like the tips of rod. MAPP gas (the yellow cans) is much hotter and will heat quicker than Propane (red cans). But it's also easier to heat too much especially in tempering!

Quenchants

- Tool Steel is designated by it's recommended quenchant. This can be things like O1 ("O" stands for Oil), A2 ("A" for Air), W2, ("W" for water … actually it means a brine solution not just plain water).
- The "severity" of each quenchant from most to least is water, oil, air. When in doubt of what you should use or if cracks develop during hardening, use a lesser severe quenchant. For example, use oil instead of water.
- For oil quenchant, use peanut oil. It isn't toxic like motor oil, mineral oil, etc.; doesn't go rancid as quickly as other vegetable or animal oils; and has a very high flash point so it's safer. Adding Vitamin E will lengthen it's "keep" time.
- Always use your quenchant in a metal container with a metal lid. Plastic melts and flash fires can and do occur sometimes.
- For long pieces of steel, dip vertically instead of horizontally. If not, you have a greater chance of warpage.
- Plunge ALL the way in at once and stir so all of the quenchant can be used at once.
- Use cool or slightly warm quenchant. Yes, it does get hot after a few quenches and won't quench well until it cools.