Metal Alphabet Soup

We may be wood workers but we need metal to create our projects. There is so much to learn in the metal work world.

Some metals are more useful for wood work than others. The most useful metal to make our wood working or turning tools is steel. There are many specifications of steel and many methods to make the steel. Each has pros and cons.

Most pure metals are not very useful. They are typically combined with other compounds or elements to improve physical or chemical properties. These are called "alloys" of the metal.

If you get a piece of iron, it will be soft and will not retain its edge. Carbon is added to improve the properties. The amount of carbon varies greatly.

As the amount of carbon increases, the steel has the ability to become harder and stronger through heat treating, however this results in the steel becoming less ductile. For example a file is very hard, perhaps one of the hardest pieces of steel in the average shop. If we accidentally flex the handle too much, it will break due to lack of ductility.

Mild steel, also called plain-carbon steel is common but will not be useful in tools. Too soft and not able to retain an edge.

Another term often seen is “HSS” which stands for High Speed Steel. A general term for the steel used to make tools for wood and metal work. However, the term does not provide sufficient information to know if one HSS tool will perform better than another HSS tool. There are likely to be differences.

HSS can withstand higher temperatures than high carbon steels without losing its temper (hardness). This allows HSS to cut faster than high carbon steels, hence the name “high speed”.

For steel there are many terms which are used. Often the person will know what the term means, but casual readers may be lost.

Steel for turning tools may be referred to as e.g., "01", "A2" and "M2". This steel alphabet soup is very complicated.

Passing on a little of the "translation" of the alphabet soup for future reference.

Metal alloys are very complicated. The chemical/elemental components are not a true mixture. In a true mixture, the molecules are dissolved and distributed completely and evenly. For example a drop of salt solution contains the same molecules in the same concentrations as any other drop from the same batch or

container.

Metal alloys are not chemical mixtures, they are called eutectics which are physical mixtures. The molecules are not all dissolved and not evenly distributed. The molecules which are dissolved or physically combined, change a lot with temperature. To add to the complexity, the physical structure of the molecules changes between liquid (molten) and solid (cooled) state. The crystalline structure of the molecules in the liquid state is also based on temperature. Hence as the liquid cools, it is changing in chemical composition and crystalline structure. Very complicated. The rate of cooling the liquid, called quenching, significantly impacts which composition and / or crystalline structure is "captured" in the solid state. See the Woodworkers Guide to Tool Steel and Heat Treating link below for the details.

There are 3 common methods to quench molten steel, Air, Oil and Water. Like everything, there are other approaches like a brine (salt) solution. A more recent quench method combines one of these with spraying the molten steel into droplets so they are quenched much faster than a single solid piece. This is the class of powdered metals. The power is then recombined to make a solid piece by sintering at controlled temperatures.

"O" steels are Oil quenched. "A" steels are Air quenched". "W" steels are water quenched.

A detailed explanation of heat treating at this site.

A Woodworkers Guide to Tool Steel and Heat Treating

For folks who prefer to see a video, this is a useful video on heat treating. I like seeing the temperatures. Also liked the method of heating a piece of metal red hot and placing the piece on top then watching for the temper colour. Very even result.

https://www.youtube.com/watch?v=qQ9eysoFjsk

Interesting link on use of water vs oil for quenching.

http://www.metalsmith.org/pub/mtlsmi...3/TTTCURVE.htm

The quenching method of steel must be repeated if the steel is re-heated to work or re-harden, otherwise the steel may not harden again. When the original quenching method is unknown, try oil quenching. If the steel does not harden, then try water quenching. If the steel still does not harden then try air quenching. If the steel does not harden then it was created with some unusual quenching method or is some unusual alloy.

The following is from a book I saw on-line.

"O1" is a general purpose, oil-hardening tool and die steel with good edge holding ability and high hardness levels.

"A2" is a general purpose, air-hardening tool steel which is safe hardening with low distortion characteristics and high abrasion resistance. It has a wide range of tooling applications with more abrasion resistance. A specification for "A1" steel exists, but I have not seen this at the sites to purchase tool steel.

"W1" is water-hardening tool steel supplied with a carbon content of 0.9 - 1 % Carbon. This grade hardens with a hard outside case and a relatively softer, more ductile inside core. This is often called "case hardened".

"M2" is an air, oil or salt hardening molybdenum tungsten high-speed steel with high carbon and vanadium content. It is a general purpose, high speed steel with balanced abrasion and shock resistance and good red hardness. I found the following definition of "red hardness".

Red hardness : A term sometimes associated with high speed steel because it has the property of retaining sufficient hardness for cutting metals even when heated to a temperature high enough to cause a dull redness. The tungsten content has a significant influence on this property.

"M4" is an air, oil or salt hardening molybdenum tungsten high-speed steel with high carbon and higher vanadium content. It has superior resistance to abrasion when compared to other high speed steels.

According to US turning tool manufacturer Doug Thompson, "M2" is used by most of the UK Sheffield turning tool manufacturers, Sorby, Henry Taylor, etc.

Doug claims the higher the vanadium content the better wear resistance so the longer the tool will hold its edge.

"M2" has 2% vanadium.
"M4" has 4% vanadium.

In addition to the alphabet soup, there is also a numerical code.
2030 series has 5 % vanadium. According to Doug this being phased out.
2040 series has 7 % vanadium.
Doug sells CPM-10V is a powdered metal alloy with 10% vanadium.
Doug also sells CPM-15V, a powdered metal alloy with 15% vanadium.

The powdered metals can achieve the high vanadium content since the small droplets cool so fast. According to Doug, if this was solid metal, the vanadium would come out of solution at this percentage.

If you want to look up other metal specifications, Wikipedia is a good place to begin

Wiki page on metal specifications

A couple of small metal quantity suppliers.

Metal Supermarkets has stores and franchises which may not show from the site.

http://metalsupermarkets.com/

Online Metals has frequent discount. Search for a coupon.

https://www.onlinemetals.com/

Supplier of all sorts of tool steels of several different types - this is their tool steel page. They may sell most things, but I find their site frustrating to navigate.

McMaster Carr

For drill rod I use ENCO. Many other items potentially relevant for wood workers. They often have coupons for 10 or 20% off. Sometimes also offered with free shipping.

ENCO

For folks within driving distance of Fleetwood, PA a metals recycling company M.B. Glick. They sell on Ebay, but far cheaper to pick up. Metal stock sold by weight. They will cut smaller pieces, but charge a cutting fee. Address and phone number on the web site.

Moses B. Glick