

Tempering Metals

by Tom Noser

Tempering - The term " temper " as used by steel makers , refers to the percentage of carbon in the steel. It has a different meaning when used by

the hardener. In the steel mill it means the amount of carbon steel contains. The meanings have been tabulated by an authority as follows:

Very high temper.....150-point carbon

High temper.....100 to 120-point carbon

Medium temper.....70 to 80-point carbon

Mid temper.....40 to 60-point carbon

Low temper.....20 to 30-point carbon

Soft or dead soft temper.....20-point carbon

A "point is 1/100 of 1 % of any element that enters into the composition of steel, so a 150-point carbon steel contains 1 ½ % carbon. In the steel mill such a steel is spoken of as 150 steel.

Tempering, on the other hand, also denotes the process by which steel is brought to a previously determined degree of hardness. A steel chisel can be made so hard that it will cut another piece of steel; or so soft that driving it into a piece of hardwood will dull its point. This property of steel enables the mechanic to make it into tools suitable for any kind of work.

Steel is tempered by various means, all of which depend upon a heating and subsequent cooling of the metal. For instance, a piece of tool steel which is heated to a cherry red and then plunged into cold water, becomes very hard. If allowed to cool slowly, it becomes soft. Between these two extremes all degrees of hardness can be obtained. Every tool is tempered to the degree of hardness that makes it most useful.

When a polished piece of steel, hardened or unhardened, is exposed to heat in the presence of air, (it's surface) assumes different colors as the heat increases. First will be noted a faint straw color, which changes to a deeper straw, then to dark brown with purple spots, then to a dark blue, and finally to a light blue. These colors are due to a thin film of oxide that forms as the heat progresses. These colors are valueless, however, to the tool maker unless the metal has first been cooled in a bath of water, oil, or some other liquid, when at red hot. Drawing hardened steel to any of these colors is called tempering. The following list of colors applies to all of the tools commonly made:

Color Tool: Visual Temper Gauge

Pale or light straw.....Lathe tools

Dark straw.....Taps, dies, milling cutters, etc, woodworking tools (cooled in oil)

Purple.....Center punch, stone drills

Dark blue.....Cold or cape chisels

Light blue.....Screwdrivers

Tool Tempering.— Let us now consider the tempering of a tool, taking for example the cold chisel, a tool widely known and generally abused. To obtain a chisel, it must be properly forged at a comparatively low heat, and then hammered with light blows at the last until it has cooled considerably below the heat ordinarily used when metal is displaced. The object of the light blows on the cooling metal is to close the grain or refine the steel, making it tough. Tools of this character stand up better if they are heated to a cherry red heat and cooled before hardening(as mentioned above.)S This is not always possible but when it is make the hardening heat a separate operation.

To harden, heat two thirds of the part forged to a cherry red heat, using great care not to overheat the point, and then cool one half of the blade in cold water; always move the tool about or set the water in motion, avoiding any danger of making a water crack at the water edge.

The next operation is to brighten one broad surface with an emery stick. A piece of emery cloth tacked over a stick of wood makes a very good polisher. The heat remaining in the body of the piece will reheat the end just cooled, and the various colors will appear in order on the polished surface. The proper color for a cold chisel when correctly tempered is dark blue. When this color is attained at the point the entire tool is immersed in cold water and is not removed until cold. If the tool is not cooled off enough in the first operation, the colors will run down very rapidly and become compact, and if not watched very closely, they will be gone (back to cherry red)before the tool can be cooled.

When a tool is to be hardened all over, it is first heated to a cherry red and then cooled. After brightening with the emery stick, put on a square or flat piece of hot iron. The tool will absorb the heat and the colors will soon commence to run. When the desired color is obtained, cool again in water or oil.

Spring Tempering.- The method employed in hardening a spring in oil is as follows : First, heat to a cherry red as in hardening in water ; cool all over in oil; hold over the fire until the oil upon the surface blazes. This is called "flashing." Cool again in oil. This "flashing" is done three times before the process is complete. Another method of hardening a spring employs water instead of oil. Pass the spring over the fire or through a flame until it is hard enough to make a pine stick show sparks (??????) ; then cool in water and a spring "temper" results.

Annealing.- The process of softening a piece of steel is called "annealing." A piece of steel is softened or "annealed" prior to being worked on in the lathe or otherwise machined, as this process brings about a uniform softening, relieving any strain that might have occurred in forging. To anneal a piece of steel, it should first be heated to a cherry red heat, and then allowed to cool slowly.

The above commentary is presented partly as a matter of historical interest, but particularly because we often need to re-temper things like landing gear. You will find that you need two different torch heads when doing things like silver soldering, one for point heating with a fine, intense pencil-point flame, and one with a diffuse flame for better control of temperature for longer periods of time...'til next time...wheels up.