

## COPPER DATA TEMPER AND HOW IT IS SPECIFIED

The temper or hardness of a metal or an alloy is a condition produced by mechanical or thermal treatment. This treatment imparts a characteristic structure and mechanical properties. Temper ranges from annealed, or fully soft, to spring temper, or very hard. Annealed temper is achieved by thermal application; spring tempers—and intermediate tempers—by cold-working (rolling or drawing). Rolling and drawing of a metal reduce its thickness, but increase its hardness.

In standard mill practice, the reduction by rolling is figured on the basis of thickness, only because the metal does not widen very much during the rolling operation. The degree of rolling is expressed in Brown and Sharpe gauge numbers, which were developed many years ago and which have a definite relationship to each other. For example, in the Brown and Sharpe gauge system, the gauges are reduced by 50 percent every six numbers as shown below:

No. 2 B&S is .2576 inch  
No. 8 B&S is .1285 inch  
No. 14 B&S is .06408 inch

**Specifying Temper.** The strength and degree of hardness of the metal is of the utmost importance. The fabricator should supply definite specifications concerning his requirements on temper to avoid misunderstandings.

When forming or bending operations are to be made, the material must not be too hard. As large a bending radius as practical should be used to favor the hard metal. It should be understood that bends made perpendicular to the direction of rolling are less liable to fracture than those made parallel to the direction of rolling. Generally, half hard temper is satisfactory, but there are some instances where quarter hard temper should be used. Ultra Fine Grain, which approximates regular quarter hard temper but with greater ductility and better polishing characteristics, may be preferred.

**Strip and Sheet Tempers.** The following standards for hard-rolled flat metals have been universally adopted for strip and sheet by the brass industry and given in ASTM specifications:

TEMPER	ROLLED B&S	% REDUCTION IN THICKNESS
Quarter hard	1 B&S number hard	10.95%
Half hard	2 B&S numbers hard	20.7%
Three quarter hard	3 B&S numbers hard	29.4%
Hard	4 B&S numbers hard	37.1%
Extra hard	6 B&S numbers hard	50.15%
Spring	8 B&S numbers hard	60.5%
Extra spring	10 B&S numbers hard	68.65%

To obtain metal .010" thick, "hard" temper, (metal .010" thick corresponds to 30 B&S) the mill takes 4 nos. B&S thicker than No. 30; namely, No. 26 (.0159), anneals it, then rolls it to No. 30 without intermediate anneal, leaving it in its rolled condition at this finishing thickness. For uniformity of temper, the grain size of the metal in the annealed condition, before the final rolling, must be controlled.

**Rod Tempers.** Free-cutting brass rod, which comprises the largest percentage of screw machine items, is generally furnished cold drawn in standard tempers and sizes. Screw machine items which must be roll-threaded, knurled or swaged require softer temper depending on the severity of the cold working operations. To avoid misunderstandings, the mill prefers to have the temper of rod expressed in "percent of reduction in area by cold working."

A certain amount of work-hardening in rod has definite advantages. It provides hardness and strength to withstand the bending pressure of the cutting tool and favors chip-separation. Smaller sizes of rod are usually furnished with a harder temper than the larger sizes. To meet special specifications, Rockwell hardness tests, and sometimes tensile tests, are used to control the physical properties.

When specifying temper of drawn tubes, the term "percent reduction in area" by cold-drawing is much more definite and less subject to error than terms such as "light drawn," "quarter hard," "half hard" and "hard." For special applications, temper is controlled by Rockwell hardness limits and occasionally by tensile tests.

Specifying correct tube tempers will pay for itself many times over by eliminating costly mistakes and misunderstanding.

Tubes for screw machine work, without any subsequent cold-working operations, can be drawn as hard as possible with the percent reduction in area depending upon the size. On the other hand, tubes for screw-machine work—which have to take some light, cold-working operations after machining, such as deep knurling or expanding—would be furnished in a "light drawn" temper, the reduction depending upon the severity of the operation.