A.J. Fuller, Jr., Introduction to Carburizing and Carbonitriding, *Steel Heat Treating Fundamentals and Processes*. Vol 4A, *ASM Handbook*, ASM International, 2013, p 505–521.

Carburizing Steels

The distinguishing characteristic of carburizing steels is a low carbon content. Carburizing steels typically have a carbon content of between 0.10 and 0.30%, although steels with higher carbon contents are sometimes used in special applications. Carburizing steels can be plain carbon or alloy steels containing small amounts of alloying elements, typically manganese, chromium, nickel, and molybdenum. There are many grades available. Some popular carburizing steel grades are described in Table 3. These alloying additions are intended to either increase hardenability or enhance other properties, such as impact strength.

Table 3 Common carburizing steels

AISI grade	Relative cost	Nominal composition, wt%					Comments
		C	Mn	Ni	Cr	Mo	
1020	Very Low	0.2	0.45	…	…	…	Plain carbon steel. Low core hardenability
4023	Low	0.23	0.80	…	…	0.25	Low-hardenability grade commonly used in automotive applications
4320	Moderate/high	0.2	0.55	1.82	0.50	0.25	Higher hardenability for improved core response in thicker cross sections. Somewhat longer processing times than 8620
4620	Moderate	0.2	0.55	1.85	…	0.25	Nickel/molybdenum steel. Used only where nominal hardenability and core response are required
4820	High	0.2	0.60	3.5	…	0.25	Increased nickel content for improved core toughness. Slower response results in longer processing times
5120	Low	0.2	0.80	…	0.80	…	Commonly used in automotive applications. Propensity to form carbides if carburized too close to saturation
8620	Low/moderate	0.2	0.85	0.55	0.50	0.20	Most commonly specified steel for carburizing. Excellent carburizing response, with good hardenability for most section sizes
8720	Moderate	0.2	0.85	0.55	0.5	0.25	Similar to 8620 but with additional molybdenum for increased core hardenability
9310	Very high	0.1	0.50	3.25	1.2	0.12	Increased nickel content for maximum core toughness. Slower response results in longer processing times

The steels listed in Table 3 are a sampling of grades commonly used in North America. There are various steel chemistries in use in different regions around the world, many of which are analogous to certain AISI or SAE grades. Grade selection should be based on local availability and the ability to satisfy the case and core requirements. There is usually a standard grade available to meet most applications, but in rare cases, the application may have special requirements that dictate the extra cost of using a custom grade.

Carburizing steels should be treated for grain refinement, because the elevated temperatures and extended times of commercial carburizing processes can create the potential for undesirable grain growth in the finished part.

With the rise in popularity of vacuum carburizing, there has been a greater interest in carburizing at temperatures above 980 °C (1800 °F). When carburizing above 995 °C (1825 °F), consideration must be given to factors such as furnace construction, process used (vacuum and/or atmosphere furnace), alloy fixture life, and workpiece material. Grain growth and intergranular oxidation at the surface are undesirable effects that can occur more rapidly at high temperatures. Various combinations of alloying elements are being used by steel manufacturers to resist these deleterious effects. It is important to recognize that steel grades used to make components that will be carburized at high temperatures may need to compensate for loss of elements in vacuum high-temperature carburizing. Certain alloying elements such as niobium may be added to help prevent grain growth.