For a predominantly spheroidized structure, heat to 1380 °F (750 °C), cool rapidly to 1300 °F (705 °C), then cool to 1050 °F (565 °C) at a rate not exceeding 5 °F (3 °C) per hour; or heat to 1380 °F (750 °C), cool rapidly to 1200 °F (650 °C) and hold for 12 h. A spheroidized structure is usually preferred for both machining and heat treating.

Hardening. Austenitize at 1550 °F (845 °C) and quench in oil. Thin sections may be fully hardened by air cooling.

Tempering. In common with all high-hardenability steels, 4340H is susceptible to quench cracking. Before parts reach ambient temperature (100 to 120 °F, 38 to 49 °C), they should be placed in the tempering furnace. Tempering temperature depends on the desired hardness or combination of mechanical properties (see Fig. 3).

E52100 — Recommended Heat Treating Practice

Normalizing. Heat to 1625 °F (885 °C) and cool in air.

Annealing. For a predominantly spheroidized structure that is generally desired for machining as well as heat treating, heat to 1460 °F (795 °C) and cool rapidly to 1380 °F (750 °C), then continue cooling to 1250 °F (675 °C) at a rate not exceeding 10 °F (6 °C) per hour; or as an alternative technique, heat to 1460 °F (795 °C), cool rapidly to 1275 °F (690 °C) and hold for 16 h.

Hardening. Austenitize at 1550 °F (845 °C) in a neutral salt bath or in a gaseous atmosphere with a carbon potential of near 1.0%, and quench in oil.

Tempering. After quenching, parts should be tempered as soon as they have uniformly reached near ambient temperature. 100 to 120 °F (38 to 49 °C) is ideal. Because of the high carbon content, parts must be tempered to at least 250 °F (120 °C) to convert the tetragonal martensite to cubic martensite. Most commercial practice calls for tempering at 300 °F (150 °C), which does not reduce the as-quenched hardness to any significant amount. When a reduction in hardness from the as-quenched value of approximately two points HRC can be tolerated, a tempering temperature of 350 °F (175 °C) is recommended. Sometimes E52100 is subjected to higher tempering temperatures, with an accompanying loss of hardness (see Fig. 3).

Effects of Tempering

From the data presented in Fig. 3, it can be seen that the as-quenched hardness of alloy steels is a function of carbon content, reaching a maximum of about 65 HRC for E52100. There is, however, some difference in the rate at which hardness decreases with increasing tempering temperature for alloy steels, as compared to carbon steels. This simply indicates the effects of alloy upon softening by increasing temperature; note especially the hardness versus tempering curve for 4340, 4340H in Fig. 3.