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AUSTEMPERING OF CARBON STEELS FROM HIGH TEMPERATURES

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Isothermal quenching of complex-shaped C-steel tools from the usual austenitizing temperatures considerably cuts distortion, but is not practically usable since it does not produce the required high hardness. Hence alloy instead of carbon steels are used for making complicated tools which are conventionally hardened with subsequent straightening. To increase the stability of supercooled austenite in carbon steels in the pearlite and bainite ranges, we have adopted a higher initial temperature, so that the tools could be quenched in hot media.

Fig. 1 shows the effect of austenitizing temperature of specimens of 5 mm (0.2 in) diameter of steel U7 (nominal 0.7% C, 0.20-0.40% Mn, 0.15-0.35% Si) on its hardness after quenching in oil at 130°C (265°F).

Steel properties are affected also by the heating rate and holding time at a particular temperature. To avoid grain growth at high temperatures, the heating rate should somewhat exceed the grain growth rate. This can be achieved for certain tools by heating in salt baths. Fig. 2 shows the variation of the core hardness in specimens of 10 mm (0.4 in) diameter of steel U8 (nominal 0.8% C) with the time of heating at 1000, 1100 and 1200°C (1830, 2010 and 2190°F), followed by oil quenching at 130°C (265°F). A Rockwell C hardness can be achieved by heating at 40°C (72°F)/sec to 1200°C, 20°C (36°F)/sec to 1100°C, and at 10°C (18°F)/sec to 1000°C; the holding times being 0.5, 1, and 1.5 mins. resp.

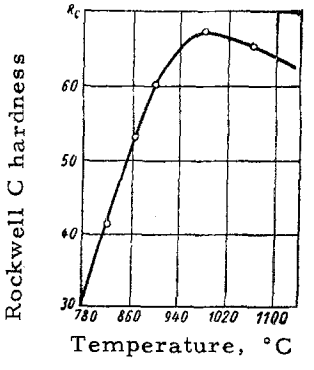

Fig. 1. Effect of the heating temperature of steel U7 on its hardness after quenching in oil at 130°C (265°F)

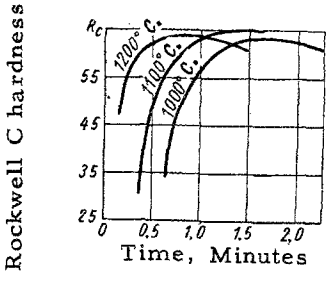

Fig. 2. Variation of core hardness in specimens of 10 mm (0.4 in) diameter with time of salt bath heating.

We found that the holding time in the salt bath should be, per mm of section (0.04 in): 3 seconds at 1200°C, 6 seconds at 1100°C and 10 seconds at 1000°C.

Under these conditions specimens and tools remain fine-grained. There is appreciable grain growth only when the holding time is 3-4 times that in Fig. 2. The distortion in quenching was measured on ring-shaped specimens of the French type. When these specimens are quenched in water from 1200°C after 0.5 minute holding, the deformation between jaws was 0.37 mm (0.0145 in), and after a quench into oil at 130°C, it dropped to 0.04 mm (0.0016 in). The hardness was 60-62 Rockwell C points.

At the Perm Retail Shop Equipment plant, austempering in hot oil after rapid heating to high temperatures has completely eliminated rejects due to cracks in meat mincer disks which previously was as high as 30%.

This method should find wide application in quenching small parts and tools of complicated shape of plain carbon steels which are susceptible to cracking and distortion.

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