CAUTIONARY TALE

Part VII   Heat Treatment – Austemper

This cautionary tale is the second in a series of three about heat treatment. The first dealt with harden and temper after hot coiling. This second deals with austempering (and harden and temper) after cold forming of annealed material. For the most part, it is springs made from carbon steel strip materials that are austempered, a process that is an alternative to harden and temper for most strip springs.

Austempering is a single stage heat treatment in which as-formed springs are heated to austenitising temperature under a protective atmosphere and then quenched into a liquid salt at 300-350°C (570-660°F) for 20-30 minutes to produce a bainitic structure. No tempering is necessary and the hardness of the springs will be in the range 450-550Hv, the low hardness resulting from the higher salt temperature. Austempering is a very reliable heat treatment process, but there are a few occasionally encountered problems of which spring manufacturers should be aware:

The first problem that can arise is with the protective atmosphere. It is intended to prevent oxidation and decarburisation of the steel surface, dissociated ammonia being the most frequently used. Control of the dew point is essential if this atmosphere is to provide the required performances. Less than –50°C (-60°F) is the required dew point. Higher dew points lead to a layer of complete decarburisation at the steel surface, which will obviously detract from a spring's performance – see Figure 1.

Austempering is generally used for thin strip springs, but thicker section carbon steels will not be quenched quickly enough to avoid some transformation to pearlite 0.7% carbon steel ought to be austempered successfully at thicknesses up to 3mm in IST's experience, but for disc springs it is common practice to use CrV steel at thicknesses over 1.25mm in order to avoid this problem. Small amounts of pearlite in a structure of lower bainite will lead to abnormal brittleness.

Insufficient time at the transformation temperature (300-350°C) will lead to transformation of any remaining austenite to martensite. A significant proportion of martensite in a structure of lower bainite will also lead to an abnormally brittle spring.

The most common salt used for austempering is a mixture of sodium and potassium nitrate and sodium nitrite. When parts emerge from this salt it is very important that any residual salt left clinging to the springs is washed off. The salt is water-soluble. Failure to wash the springs will lead to the salt attracting water from the atmosphere (it is deliquescent) and this will lead to rusting.

A final consideration is distortion. Austempering is said to reduce distortion of some components, whereas harden and temper is better for others. Distortion can arise due to parts being laid one on another in the hardening zone, due to damage as the parts tumble off the belt or shaker hearth, due to relief of forming stresses as the parts are heated or due to transformation. During transformation from austenite to bainite, there is a volume expansion of about 3% and from austenite to martensite; the expansion is about 4%. Hence, if your distortion is mainly arising from the transformation, then austempering should be the preferred process. Zero distortion is unattainable, as will be obvious from this description.

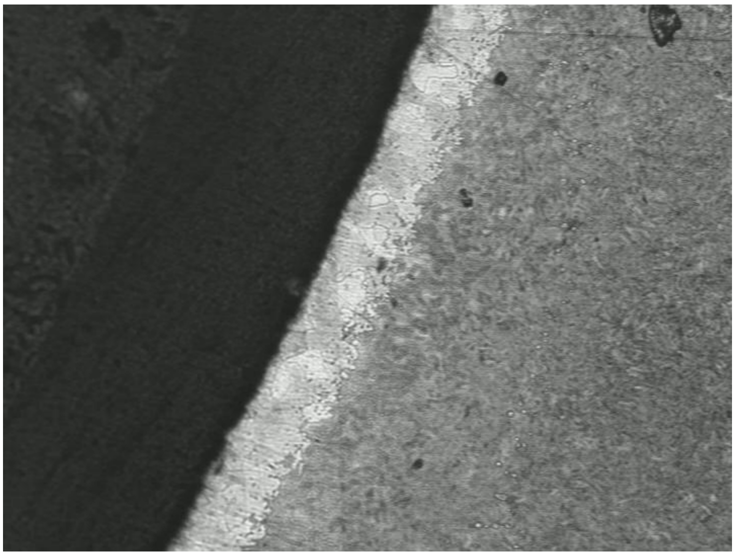

Figure 1 x 175

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