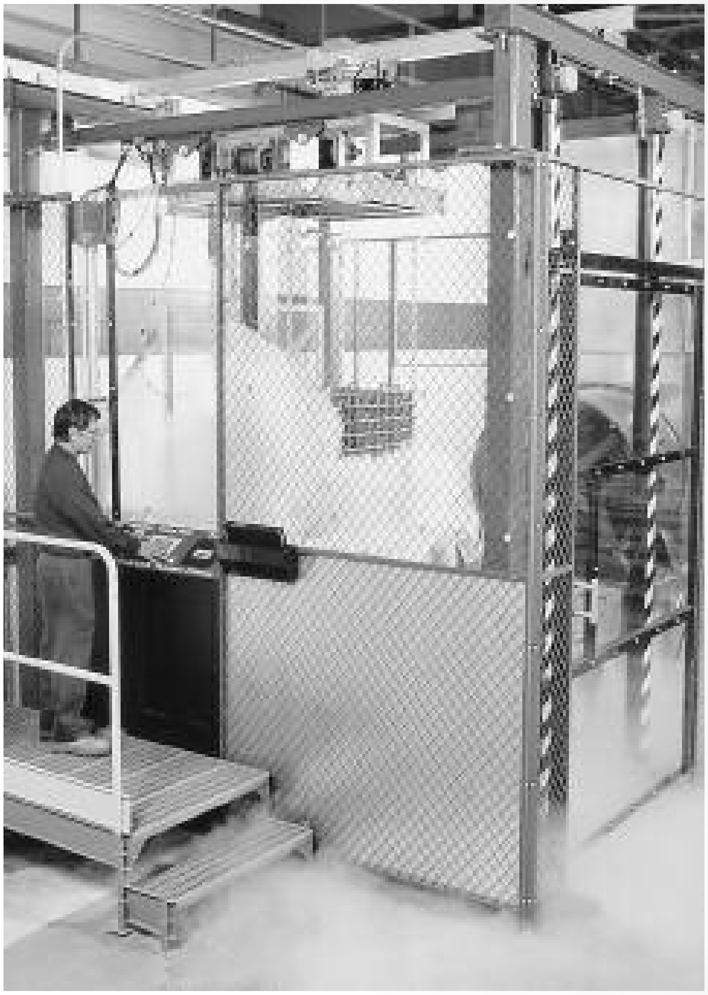
BÖHLER UDDEHOLM™
Thermo-Tech

Quality Heat Treatment of Tool Steels

VOLUME 2

CRYOTHERM℠

For applications that require excellent dimensional stability



Why CRYOTHERM℠ treatment?

- ***Dimensional Stability***
- ***Higher Fatigue Strength***
- ***Increased Wear Resistance***
- ***Resistance to Indentation***

Image courtesy of G&G Machine Knife

The CRYOTHERM℠ Process

The CRYOTHERM℠ process is a controlled sequence of repeated heating and cooling to cryogenic temperatures, which enhances tool performance in terms of higher fatigue strength, wear resistance, hardness and dimensional stability. The process differs qualitatively from conventional dunking in a liquid nitrogen bath, which has been known to cause brittleness and frequent cracking. Through a fine balance between heat treatment process parameters, special tempering cycles and precise control over the cooling and thawing operations tools attain optimum properties. Since tools differ widely with respect to operational requirements, shape, size and material grade, not all of them can be subjected to the same process.

The cryogenic part of the process is carried out in specifically designed fully automated computerized equipment. Since liquid nitrogen is being lost to atmosphere through evaporation during processing, a thermocouple continuously monitors and records the temperature in the liquid bath for quality assurance purposes.

Thermodynamics and Physics

Heat treatment of tool steels involves heating above the phase transformation temperature to dissolve alloying elements into austenite. For a typical tool steel composition, austenite (because of its different crystallographic configuration) has ~4.09% less specific volume than its end product martensite. Being thermodynamically unstable at normal temperatures, changes in part size are inevitable if this low specific volume phase austenite is not eliminated from the hardened structure during the manufacturing process.

Tool steels, due to their high alloy contents, are prone to retain austenite after conventional heat treatment. Austenite, being a weaker high temperature structural phase, transforms to more stable phases

A remedy for:

- Contact fatigue failures: spalling and chipping
- Shallow surface cracks which lead to fractures
- Dull rounded edges
- Poor fit function

(martensite and bainite) under the conditions of mechanical working and heating. Steel grades such as O1, A2, D2, S7, M2, 52100, etc. possess 10-40% retained austenite in common heat treatment practices which is not acceptable for metal cutting or cold forming tools that operate under high point stresses. Treating these materials at cryogenic temperatures (-320F) has been reported to improve wear resistance dramatically, while strengthening the matrix. Researchers have reported improvement to the order of two to over six times the normal heat treatment. If your tools are failing due to excessive wear, rounded edges or chipping/spalling, or you are worried because of dimensional changes during finishing or in operation, then CRYOTHERM℠ is good news for you.

Low shear strength and resistance to indentation (hardness test) sets the stage for early wear. In abrasive wear, metals fail through yielding in stretching and shearing. No surprise, retained austenite provides favorable spots for the hundreds of thousands of abrasive particles to plough through the metal surface easily. CRYOTHERM℠ transforms the trapped retained austenite into harder phase, it also strengthens the metallic matrix through precipitation of fine carbides. The final structure is thus much more homogenous, stable, stronger and wear resistant.

Thermodynamics and Physics, Cont'd.

Applications

- ❑ Precision gauges and machine parts engaged in interactive controls, relative motion and parts exposed to extremely low temperature during service.
- ❑ KNIVES: Industrial, Domestic, Surgical.
- ❑ Fine Blanking Dies where consistency in exact dimensions is required.
- ❑ Tools momentarily subjected to very high temperature such as hot shear knives, hot forging dies, high speed machining tools, etc.
- ❑ Parts subjected to higher degree of scuffing; no matter which coating is applied, gouging and scoring is inevitable, parts of powder pressing, metal scrap recycling, shredding machinery.
- ❑ Machine tool parts which work under high degree of contact fatigue: bushings, journals and bearing surfaces. High performance high speed motor vehicle gears, shafts, and engine parts. Carburized low alloy machine parts: gears, pinions, and spline shafts.
- ❑ High speed machining and cold working tools working under extreme conditions of point load and high temperatures: drills, reamers, taps, hobs cutters, thread rolling dies, end-mill, punch and dies, indexable tools.
- ❑ Aerospace industry components.
- ❑ Tools to be coated with hard PVD and CVD surface coatings.
- ❑ Earth/rock moving machinery blades.

Eta-Carbides

Research into the physics of transformation, that is responsible for phenomenal increases in the wear resistance of steel grade T15 has shown that under specific conditions of cryogenic treatment and tempering, (which differs from conventional industry practice) a special class of fine alloy carbides called Eta-Carbides precipitates at specific orientation in the structure. The above mechanism has not been found active in normal heat treatment and tempering cycles.

• If you are not getting the optimum performance from your tools or machine parts, **CRYOTHERM**SM can make a difference. Contact us for a detailed free assessment. Supporting our commitment to the success of our customers, Böhler-Uddeholm Thermo-Tech operates a fully equipped metallurgical lab in Mississauga, Ontario, Canada.

Experiencing a problem?
Give us a call

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