BÖHLER UDDEHOLM
Thermo-Tech

Quality Heat Treatment of Tool Steels

TOOL STEEL WELDING

The weldability of steels with more than 0.2% carbon is usually considered to be poor. Tool Steels with 0.3–2.5% carbon as well as alloying elements such as manganese, chromium, molybdenum, tungsten, vanadium and nickel, are difficult to weld and many steel suppliers will actually recommend against welding.

Böhler-Uddeholm recognizes that Tool Steel often needs to be welded; this is especially true for expensive tooling like die-casting dies, large forging dies, plastic moulds, car body dies and blanking tools where repair and adjustment via welding is highly cost attractive in comparison with the expense of producing new tooling.

The main problem in welding Tool Steel stems from its high hardenability. Welds cool quickly once the heat source is removed and the weld metal and part of the heat affected zone will harden. This transformation generates stresses because the weld is normally highly constrained, with a concomitant risk for cracking unless great care is exercised.

Improved quality of consumables, refined welding equipment, developments in welding technique and, not least, improvements in Tool Steel quality have combined to render tool welding as a realistic possibility, which can have considerable economic consequences.

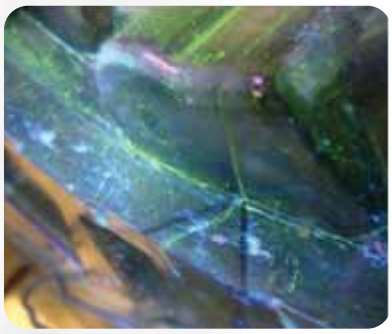
General Information on Welding of Tool Steel

Welding of tooling may be required for any one of the following reasons:

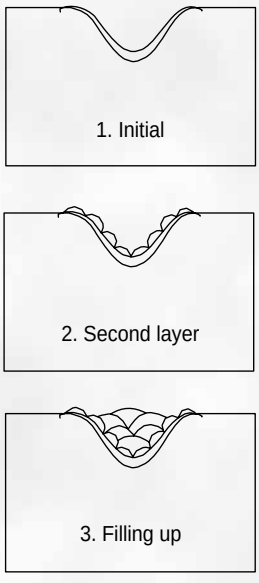
- refurbishment and repair of cracked or worn tooling;
- restoration of chipped or worn cutting edges, e.g. on blanking tools;
- adjustment of machining errors in tool making;
- design changes.

What follows is a description of some of the capabilities available at Böhler-Uddeholm Thermo-Tech along with a brief description of welding preparation, pre and post welding processing, weld consumables, etc. that are required in order to weld Tool Steel successfully. Of course, the skill and experience of the welder is also a vital ingredient in obtaining satisfactory results. With sufficient care, it is possible to achieve weld repairs or adjustments which, in terms of tooling performance, are hardly inferior to that of the base steel.

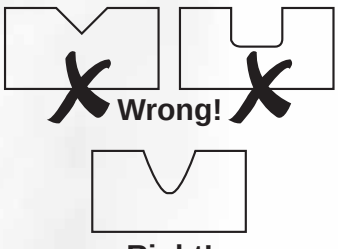
Capabilities available at Böhler-Uddeholm Thermo-Tech



Pass sequence



Joint Preparation



Magnetic Particle Inspection

Magnetic particle inspection is a non-destructive inspection method used for detection of surface cracks in ferrous parts. It is used to inspect the tool prior to any weld preparation to locate potential cracks; it is often the case where besides the obvious visible cracks there may be cracks that appear during the preheat process prior to welding. At Böhler-Uddeholm Thermo-Tech we employ both the dry particle and wet fluorescent types. Once the cracks have been identified the cracks should be properly ground down to sound steel. This can be verified by the use of either wet or dry magnetic particle inspection method prior to preheating the tool.

Weld Joint Preparation

When minor joint preparation is required our skilled welding staff can perform the necessary preparation; when major extensive joint preparation is required our technical staff can make sound recommendations.

Ultrasonic Inspection

Ultrasonic inspection is a Non-Destructive Testing (NDT) method for detecting internal flaws such as cracks and voids. Ultrasonic testing can be performed by Böhler-Uddeholm Thermo-Tech to evaluate a visible crack depth, as well as potentially locate a crack that may not have as yet travelled to the surface of a tool.

Pre-heating Capabilities

In order to achieve successful weld repairs, it is necessary, prior to welding, to preheat the entire tool to a temperature 50˚C - 100˚C (90˚F - 180˚F) above the critical temperature which is the Ms (Martensite-start temperature). Böhler-Uddeholm Thermo-Tech operates tempering furnaces for preheating up to 56” x 68” x 74”. This capacity enables us to handle a wide size range of weld jobs. If the welding operation is prolonged due to the sheer size and complexity of the weld, it is sometimes necessary to interrupt the welding procedure to allow for re-heating of the tool to maintain the correct welding temperature.

Post-heating Capabilities

Fully hardened tools should be tempered after welding. This improves the toughness of the weld metal as well as the HAZ (Heat Affected Zone). This is especially important when the weld will be subjected to high stresses during operation such as in die-casting dies.

Stress tempering/relieving is important in order to reduce residual stresses.

Annealing Capabilities

Tools which are welded due to design changes or machining errors and are in the annealed condition will need to be heat treated after the final welding. Since the weld metal is hardened due to the cooling after the welding process, it is necessary to fully anneal the tool preferably as soon as possible and prior to the hardening and tempering of the tool.

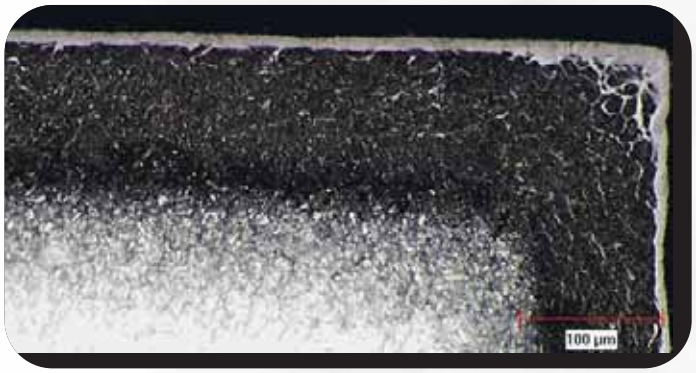
Since annealing is carried out at high temperatures where decarburization occurs, it is advisable to perform the annealing procedure using a vacuum annealing furnace (protective atmosphere). For this reason Thermo-Tech operates vacuum furnaces especially designed to handle large tools up to 6,000 lb. capacity.

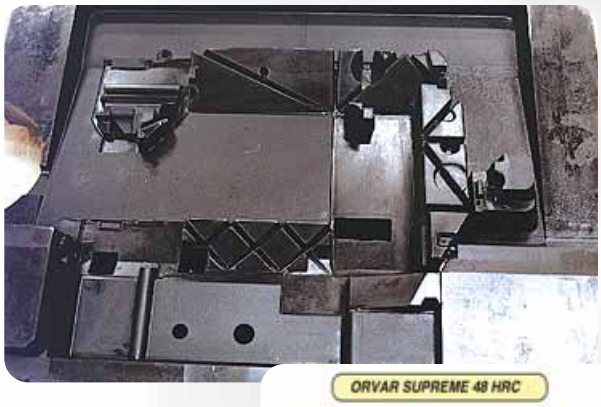
THERMONITE℠

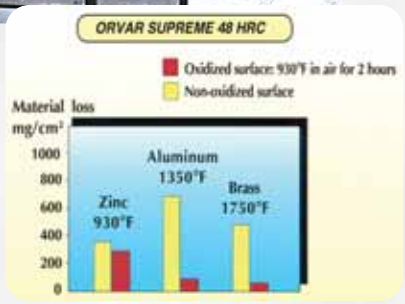
THERMONITE℠, an improved form of ferritic nitro-carburizing performed in a controlled atmosphere furnace, is a low temperature surface enhancement process that improves abrasive as well as erosive wear in die-casting applications. Welding is sometimes performed to restore tools that have failed due to erosive wear and/or excessive heat checking. After completing the welding and refinishing of the welded die inserts Böhler-Uddeholm Thermo-Tech can perform the THERMONITE℠ process in order to help improve erosive wear and heat checking resistance.

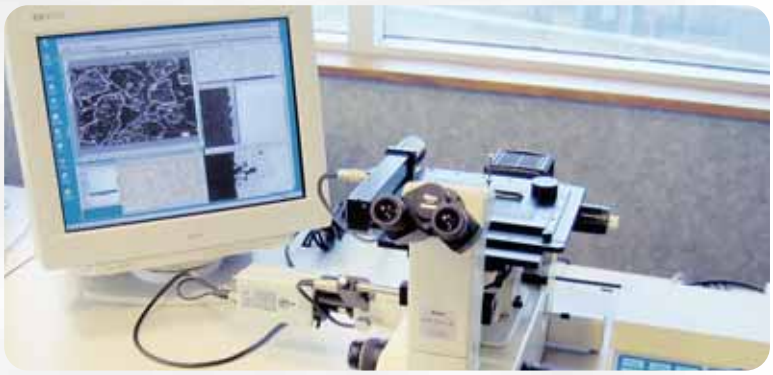
Oxide Layer

To help protect the die-casting tool during the initial running in period, it is highly recommended that the tool not be put into production with a shiny surface but rather the tool be subjected to a thermal process that will create an oxide layer on the molding surface.









Complete Heat Treating Capabilities

Böhler-Uddeholm operates a state of the art heat treat facility certified to ISO/TS 16949:2002, capable of processing to industry standards such as NADCA 207-2003 and to specific customer specifications.

Welding Specialist

We have our own highly skilled certified welder specialized in Tool Steel welding, with TIG, MIG, etc.

Unique Weld Rods

When welding Tool Steel, the consumable (filler rod) should be similar in composition to the base material. When welding in the annealed condition it is important that the filler metal has the same heat treatment characteristics as the base material; large compositional differences will increase the cracking risk during the hardening process. Böhler-Uddeholm has developed compatible welding consumables corresponding to Tool Steel such as QRO-90 Tig-Weld, Dievar Tig-Weld and Impax Supreme Tig-Weld.

Full Service Metallurgical Laboratory

Böhler-Uddeholm Thermo-Tech operates a full service Metallurgical Laboratory capable of conducting analysis that will help in providing solutions to improve tooling performance and develop recommendations on successful repair welding guidelines.

Technical Expertise

Careful evaluation of the cracked tool is required in order to identify the failure mechanism, so that the proper filler rod can be recommended for use during the welding preheating and post welding processing necessary for the successful repair or design change. Our highly experienced technical staff is available to help with the necessary recommendations.

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