

Uddeholm Caldie®

Welding recommendations

GENERAL

Uddeholm Caldie is a chromium-molybdenum-vanadium alloyed tool steel, which is suitable for short to medium-run tooling where chipping and/or cracking are the predominant failure mechanisms and where high compressive strength (hardness above 60 HRC) is necessary. This makes Uddeholm Caldie an excellent problem solver for severe cold work applications where the combination of a hardness above 60 HRC and high cracking resistance is of utmost importance e.g. in the blanking and forming of ultra high strength steel sheets.

Good results when welding can be achieved if proper precautions are taken (joint preparation, choice of consumables and welding procedure). If the tool is to be polished, it is necessary to use a filler material that has the same chemical composition as the base material.

RECOMMENDED FILLER MATERIAL

Welding Method	Gas Tungsten Arc Welding GTAW (TIG)	Gas Metal Arc Welding GMAW (MIG/MAG)	Shielded Metal Arc Welding SMAW (MMA)	Laser	Comments
Filler material	Caldie TIG Weld Unimax TIG WELD UTP A696	Dievar MIG Weld QRO 90 MIG Weld	UTP 690 UTP 67S UTP 73 G2	Tyrax Laser Weld	
	Type AWS ER 312 AWS ER NiCrMo-3		E 29 9 R		Use soft filler material for buffering layer
Hardness as welded	58 - 62 HRC Caldie 56 - 58 HRC Unimax 60 - 64 HRC A696	48 – 52 HRC	60-64 HRC UTP 690 56-58 HRC UTP 67S 55-58 HRC UTP 73 G2	55 – 60 HRC	

DIMENSIONS FILLER MATERIAL

Type	TIG			MIG	MMA			Laser
Dia. Ø mm	1.0	1.6	2.4	1.2	2.5	3.25	4.0	0.2 – 0.6
Dia. Ø Inch	0.040	1/16	3/32	3/64	3/32	1/8	5/32	0.008 – 0.024
Caldie TIG Weld	X	X	X					
Unimax TIG Weld		X						
UTP A 696		X						
Dievar MIG Weld				X				
QRO 90 MIG Weld				X				
UTP 690					X	X	X	
UTP 67S					X	X	X	
UTP 73 G2					X	X	X	
Tyrax Laser Weld								X

PARAMETERS

Condition	Soft Annealed 215 HB	Hardened 58 - 60 HRC	Comment
Preheating Temperature	250°C ± 25°C 485°F ± 50°F	250°C ± 25°C 485°F ± 50°F	The temperature should be kept constant during the welding operation. Start with buffering layers if not all cracks are removed
Interpass temperature	Max 150°C, 270°F above preheating temperature	Max 150°C, 270°F above preheating temperature	The temperature of the tool in the vicinity of the weld. When passed, the tool will have a risk for distortion, soft zones or cracking in and around the weld (the HAZ).
Cooling rate	20 - 40°, 35 - 70°F C/h The first 2 hours then freely in air <70°C, 160°F		
Post treatment	Soft anneal Harden Temper	Temper 25°C, 50°F below previous tempering temperature	Holding time when tempering, 2h. The temperature depends on the last used tempering temperature. When soft annealing and hardening, see heat treatment specification in Uddeholm Caldie product brochure.*

* Note. We have seen that in many cases a high temperature tempering, 2h, of ~750°C (1380°F) functions instead of a complete soft annealing when welding in soft annealed material.

PROCEDURES

- Clean weld area.
- Preheat material to 250°C ± 25°C / 485°F ± 50°F and maintain temperature during welding.
- Do not let the temperature in the vicinity of the weld (the HAZ) increase more than 150°C / 270°F above the preheating temperature. There is a risk of lowering (softening) the hardness of the base material or/and cracking in the HAZ. Use temple sticks or other temperature-measuring devices.
- For finishing layers use consumables which give suitable hardness.
- Wait a few minutes between each layer of strings, both for soft and hard filler, in order to let the layer equalize and minimize stresses, if possible use pre-heating furnace. Peen to minimize stresses.
- If possible, change welding direction 180° between each layer.
- Cool slowly after welding, 20 - 40°C/h, 35 - 70 °F/h for the first two hours and then freely in air < 70°C / 160°F.
- Temper 25°C / 50°F below previous tempering temperature for two hours.
- Tools welded in the annealed condition must undergo a full soft annealing immediately after welding. Allow tool to cool to room temperature before soft annealing. If a complete soft annealing cannot be done, which we recommend, a high temperature tempering at 750°C / 1380°F could be used. Be aware of that the working properties of the material will be somewhat reduced, if the high temperature tempering is used instead of the soft annealing.

Dies welded in their production equipment.

This is something, which we **do not recommend**, but we are aware of that it happens and therefore we have made the following guideline.

Pre-heat, preferably with Propane, to at least 150°C / 300°F, around the area that are going to be welded. After finished welding, let the dies go down to < 70°C / 160°F. Do a second heating, preferably with Propane, to at least 200°C / 390°F.

Use these guideline recommendations along with
“Welding of Uddeholm Tool Steel” for complete instructions.