

Uddeholm Formax[®]

Welding recommendations

GENERAL

Uddeholm Formax is a low carbon steel which can be supplied in as-hot-rolled or fine-machined condition. The material has good machinability, is easy to flame-cut, a good mechanical strength, can be case hardened and a good weldability and it is intended for use in the as-delivered condition, i.e. not heat treated.

For applications where the material must be hardened to a higher hardness, see Uddeholm Formax product brochure.

Uddeholm Formax has extremely good weldability and normally it needs no heat treatment in connection with the welding operation. However, if there is a risk of an abnormally high cooling rate, holding at 100– 200°C (210–390°F) is recommended. Stress relieving, if any, is carried out at 550– 600°C (1020–1200°F).

The low carbon content reduces hardness variations in the material after welding to a minimum.

Good results when welding can be achieved if proper precautions are taken (joint preparation, choice of consumables and welding procedure).

RECOMMENDED FILLER MATERIAL

Welding Method	Gas Tungsten Arc Welding GTAW (TIG)	Gas Metal Arc Welding GMAW (MIG/MAG)	Shielded Metal Arc Welding SMAW (MMA)	Comments
Filler material			Böhler FOX EV 50 ESAB OK 48:00	
	Type AWS ER 312 AWS ER NiCrMo-3		E 29 9 R	Use soft filler material for buffering layer
Hardness as welded				

PARAMETERS

Condition	Soft Annealed 170 HB	Comment
Preheating Temperature	100 – 200°C 210 - 390°F	Uddeholm Formax has extremely good weldability and normally it needs no heat treatment in connection with the welding operation. However, if there is a risk of an abnormally high cooling rate, preheating is recommended. Start with buffering layers if not all cracks are removed.
Post treatment	Stress relieving at 550 °C – 600°C 1020°F – 1200°F	Stress relieving, if any, is carried out at 550– 600°C (1020–1200°F). The low carbon content reduces hardness variations in the material after welding to a minimum

FLAME-/INDUCTION HARDENING

Temperature	Post treatment	Surface hardness	Comment
850 – 870°C 1560-1600°F	Cool in water	40 ±3 HRC	41 HRC at a depth of 1 – 2 mm when flame hardening. Can be increased when induction hardening depending on the coil and the power input. Flame-/induktion hardening can be done over an edge weld. Temper immediately after hardening.

PROCEDURES

- Clean weld area.
- If material is thicker than 25 – 50 mm / 1 – 2 Inch and there is a chance of a fast cooling rate, then preheat the material to 100 – 200°C / 210 - 390°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 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.
- Stress relieving at 550 °C – 600°C / 1020°F – 1200°F.
- The low carbon content reduces hardness variations in the material after welding to a minimum.

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