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TOOL STEEL HTCS®-170

(08/2008 Revision)

The Tool Steel HTCS®-170 is a semi-hot work tool steel with very high thermal conductivity (up to over 53 W/mK) combined with a extreme wear resistance even when big abrasive particles are present. This tool steel has specially been designed for the hot stamping of uncoated sheet. It can also be used for any other application requiring high conductivity and wear resistance at the same time.

Characteristics and applications

The Tool Steel HTCS®-170 is a remelted alloyed tool steel for hot work. The remarkable mechanical properties with special mention to wear resistance, even when produced by big abrasive particles combined with its very high thermal conductivity compared with other hot and cold work tool steels (at the working hardness of 52 HRc thermal conductivity is 53 W/mK when the applied heat treatment is the indicated one), make this steel an optimal candidate for the hot stamping of uncoated sheet. Any other application requiring high wear resistance and benefiting from the improved thermal conductivity in terms of increased productivity or augmented resistance against thermal fatigue heat checking or thermal shock gross cracking. Although HTCS-150 is the natural choice for plastic injection moulding, if higher hardness is whished or when the injected plastic has a high reinforcement fibre content then HTCS-170 is recommended. In the case of aluminium die casting, and other light alloy die casting, HTCS-130 is the preferred choice but zones suffering from extreme abrasive wear can benefit from the usage of HTCS-170. Also in sliding contacts and other friction applications where a significant amount of heat has to be extracted trough the steel component are well suited for this material.

Hardening

It is strongly recommended to directly contact ROVALMA regarding the optimized heat treatment for a given application. If the tool steel is to be used for an application where thermal fatigue is the main failure mechanism, like die casting, extrusion or forging then the heat treatment has to be done by ROVALMA. As a general guideline, for applications not requiring high toughness:

- Slowly heat up to austenitization temperature: 1080-1120 °C
- Holding time after the core has reached the temperature should be 50 to 10 minutes depending on the austenitization temperature.
- It is very strongly recommended to make a temperature homogenization stop at 850 ºC.
- A temperature homogenization at 650 °C is also recommendable.
- Rapid cooling is desired, specially recommendable is oil cooling (cracking risk is minimal due to high thermal conductivity, heat treatment distortions are also small due to high material stability)

Tempering

To attain 50-52 HRc:

- 2 h at 540 °C + 2 h at 600 °C + 2 h at 600 °C
- Adjust Hardness to 50 – 52 HRc (maximum heat conductivity 53 W/mK)

To attain 42-46 HRc:

- 2 h at 540 °C + 2 h at 640 °C + 2 h at 640 °C
- Adjust Hardness to 42 – 46 HRc (heat conductivity should exceed 50 W/mK)

Welding

Welding a working zone

- HTCS®-Rod (Welding wire) or HTCS®-RE (Refurbished Electrodes) are to be used in order to maintain the high thermal conductivity. (if HTCS®-170 is already heat treated it is strongly recommendable to heat the piece to be weld to a temperature of 300 to 500 ºC , if HTCS®-170 is hardened at a hardness level of 50 HRc or above, heating of the pieces to be weld is mandatory.
- If the welding has been carried out on already hardened material at places between the object to be cooled and the cooling media then the whole piece has to be tempered twice after welding to fully restore the heat conductivity at the weld area.

→ Temper once during two hours (plus heating time) at a temperature of 540 to 560 °C
→ Temper once more during two hours (plus heating time) at a temperature of 590 ºC.

Plugs

- Any welding material for hot work tool steels can be used. Welding with a high Ni containing alloy is even easier. No tempering cycles are required.

Machinning

GENERAL MACHINNING PARAMETERS

Operation	Cutting tool type	HTCS-170 condition and Hardness	Depth of cut mm	Cutting speed m/min.	Feed mm/tooth or revol. (turning)	Cooling medium
Turning	TiN coated Hard Metal	Annealed at 226 HB	$1^{+4}_{-0,9}$	65^{+25}_{-15}	$0,25^{+0,25}_{-0,24}$	Synthetic emulsion (6% dilution in water)
		Hardened and tempered to 50HRc	$1^{+4}_{-0,8}$	45^{+15}_{-10}	$0,2^{+0,3}_{-0,1}$	
	Uncoated HSS AISI-T15	Annealed at 226 HB	$1^{+4}_{-0,9}$	$23^{\pm 10}$	$0,2^{+0,3}_{-0,1}$	
		Hardened and tempered to 50HRc	$0,5^{+3}_{-0,3}$	$15^{\pm 5}$	$0,15^{+0,35}_{-0,06}$	
Milling	TiN coated Hard Metal inserts	Annealed at 226 HB	$2^{+3}_{-1,9}$	85^{+30}_{-20}	$0,15^{+0,10}_{-0,014}$	
		Hardened and tempered to 50HRc	$1^{+3}_{-0,9}$	40^{+20}_{-10}	$0,07^{+0,08}_{-0,05}$	
	TiAlN coated Worm hob	Annealed at 226 HB	$2^{+2}_{-1,9}$	80^{+10}_{-15}	$0,015^{+0,03}_{-0,005}$	
		Hardened and tempered to 50HRc	$1^{+2}_{-0,9}$	40^{+20}_{-10}	$0,015^{+0,06}_{-0,05}$	
	HSS AISI-M42 Worm hob	Annealed at 226 HB	$1^{+2}_{-0,9}$	40^{+15}_{-10}	$0,015^{+0,025}_{-0,005}$	
		Hardened and tempered to 50HRc	Not recommended			
Drilling	TiAlN coated Hard Metal integral drill	Hardened and tempered to 50HRc	-	$30^{\pm 5}$	$0,01^{+0,01}_{-0,005}$	
	Uncoated HSS AISI M42	Annealed at 226 HB	-	20^{+10}_{-5}	$0,007^{+0,005}_{-0,004}$	
		Hardened and tempered to 50HRc	Not recommended			
Cutting	Bi-metallic Cutting band saw with HSS AISI M42 teeth	Annealed at 226 HB	-	$23^{\pm 3}$	$0,003^{+0,003}_{-0,002}$	
		Hardened and tempered to 50HRc	-	$16^{\pm 2}$	$0,003^{+0,003}_{-0,001}$	
Tapping	TiN coated Hard Metal	Hardened and tempered to 50HRc	-	$2^{\pm 0,5}$	-	Volatile oil
	HSS AISI M42	Annealed at 226 HB	-	$4^{\pm 1}$	-	
		Hardened and tempered to 50HRc	Not recommended			

MACHINNING WELDINGS

Operation	Welding type	Hardness HRc	Cutting tool type	Depth of cut mm	Cutting speed m/min.	feed mm/tooth	Cooling medium
Milling	Machining of the weld: 2÷3 mm. surfacing weld layer on annealed base material, the piece is hardened and tempered after the welding and prior to machining.						Synthetic emulsion (6% dilution in water)
	TIG feeding HTCS-Rod	$47^{\pm1}$	**A**	$2^{+3}_{-1,8}$	$50^{\pm10}$	$0,05^{+0,15}_{-0,03}$	
			B	$1,5^{+3}_{-1,4}$	$50^{\pm10}$	$0,02^{+0,05}_{-0,01}$	
	Refurbished **ELECTRODE** HTCS-RE	$50^{\pm1}$	**A**	$1^{+3}_{-1,8}$	40^{+15}_{-5}	$0,05^{+0,1}_{-0,04}$	
			B	$0,6^{+3}_{-0,5}$	$40^{\pm10}$	$0,02^{+0,04}_{-0,01}$	
	Machining of the weld: Hardened and tempered base material, 2-3 mm surfacing layer, no posterior heat treatment of the weld.						
	TIG feeding HTCS-Rod	$50^{\pm1}$	**A**	$1^{+3}_{-0,9}$	$40^{\pm10}$	$0,04^{+0,08}_{-0,02}$	
			B	$0,8^{+2}_{-0,7}$	$40^{\pm10}$	$0,014^{+0,06}_{-0,02}$	
	Refurbished **ELECTRODE** HTCS-RE	$62^{\pm1}$	**A**	$1^{+2}_{-0,9}$	15^{+8}_{-5}	$0,04^{+0,06}_{-0,02}$	
			B	$0,6^{+2,5}_{-0,4}$	15^{+5}_{-3}	$0,01^{+0,02}_{-0,005}$	
	Machining of thick welding where base material diffusion is negligible.						
	TIG feeding HTCS-Rod	$35^{\pm1}$	**A**	$1,5^{+2}_{-1,4}$	$50^{\pm10}$	$0,05^{+0,07}_{-0,02}$	
			B	$1^{+2}_{-0,9}$	45^{+5}_{-10}	$0,04^{+0,04}_{-0,02}$	
	Refurbished **ELECTRODE** HTCS-RE	$41^{\pm1}$	**A**	$1^{+2}_{-0,9}$	20^{+10}_{-5}	$0,06^{+0,04}_{-0,02}$	
			B	$1^{+2}_{-0,9}$	$18^{\pm5}$	$0,04^{+0,03}_{-0,02}$	

A= TiN coated Hard Metal inserts

B= TiAlN coated Hard Metal Worm hob

- The values provided in the preceding tables are those optimizing the different machining operations with the machines at the disposal of ROVALMA. With different machines the optimal value can vary, but it should fall into the tolerance range provided.
- The hardness of the weld depends on the thickness of the surfacing. Below 4-5 mm the thicker the surfacing layer the lower the hardness.

The welding machining on annealed material after annealing of the weld, as well as the machining of the welding on hardened and tempered base material after tempering of the weld pose are quite similar to the machining of the base material in the same condition and thus the parameters of the corresponding table (page3) should be employed.

Test Temperature [ºK]		300	373	473	673	Other	Units
Physical Constants							
Linear Thermal Expansion Coefficient							x 10^{-6}/K
Thermal Diffusivity							
Thermal Conductivity		53	53	50			W/mK
Specific Heat Capacity		506					J/KgK
Alfa-Gamma-Transition Temperature	Ac_1						K
	Ac_3						K
Density							x 10^3Kg/m^3
Specific Electrical Resistivity							x 10^{-8}Ωm
Elastic Modulus							x 10^3MPa
Test Temperature [ºK]						**Other**	**Units**
Mechanical Properties							
Mechanical Resistance	50 HRc						MPa
Yield stress 2 %	50 HRc						MPa
Elongation in 50 mm	50 HRc						%
Reduction of area	50 HRc						%
V-notched Charpy-Resilience	46 HRc						J
Unnotched Charpy-Resilience [7 x 10 x 55]	52 HRc						J
Wear Resistance	50 HRc						Rovalma-coeficient 2