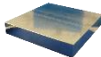


Comparison of Heat Shrink and Hydro Expansion Technology for drilling in steel

1) Experimental setup

Toolholder:		TENDO Slim 4ax	Tool holder	Heat shrink chuck	
		Hydro-expansion technology	Clamping principle	Heat shrink technology	
		Ø 12 mm	Clamping diameter D1	Ø 12 mm	
		90 mm	Cantilever length L1	90 mm	
		0206344	ID-number	0208123	
		ca. 300,- €	Acquisition cost	ca 130,- €	
Tool:	Cutting material: solid carbide				
	Design: 2-cutting edges, with IK				
Workpiece:	Material:	42CrMo4 (1.7225), tensile strength ca. 800 N/mm²			 
	Pre-machining:	board material 250x250x40mm, scale removed			
Machine / Clamping:	Machining center:	3 axes with double spindle			
	Clamping:	vice SCHUNK KSD-C 125			

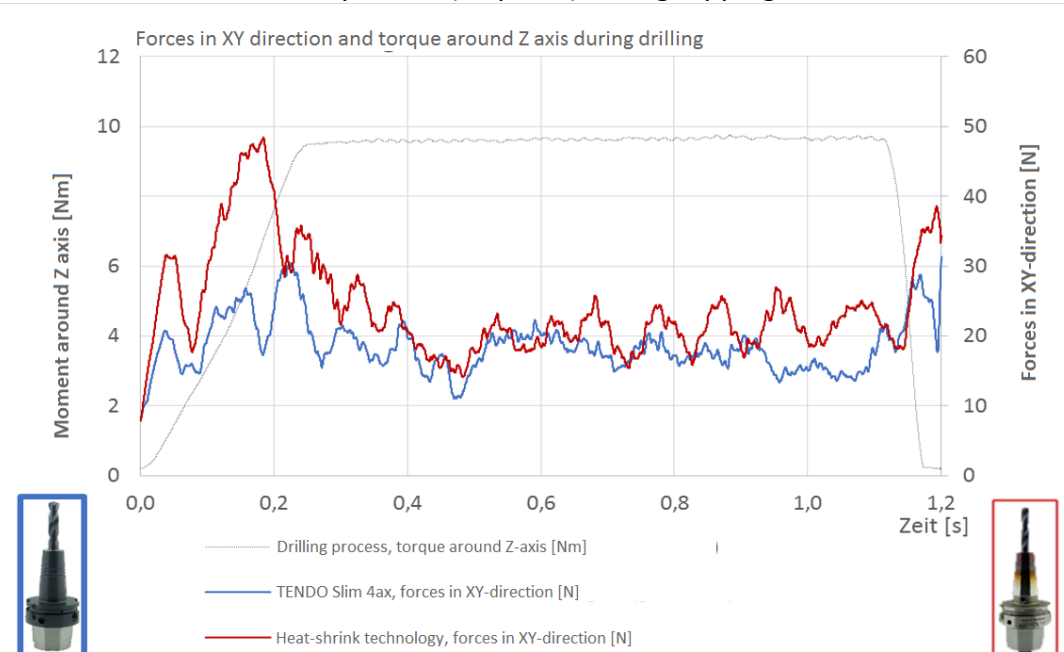
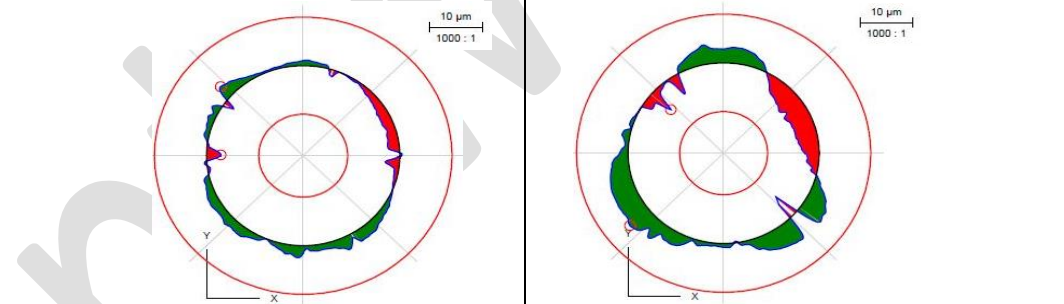
2) Test execution

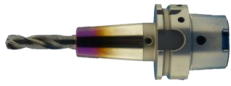
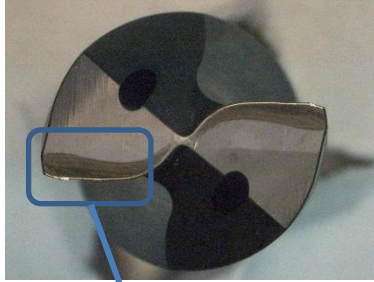
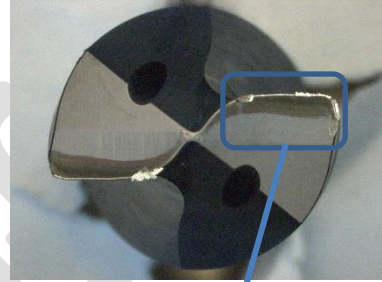
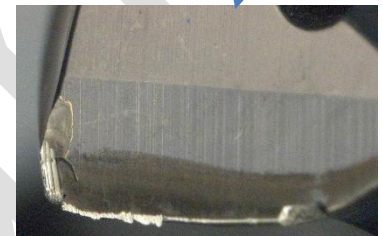
Processing:	Processing	Drilling depth	Vc	n	fz	vf
		[mm]	[m/min]	[U/min]	[mm/Schn.]	[mm/min]
	Drilling into full	36	140	3715	0,25	1876

For each workpiece, 256 holes are drilled and the cutting edges are then examined with a microscope. This process is repeated until clear breakouts are visible.

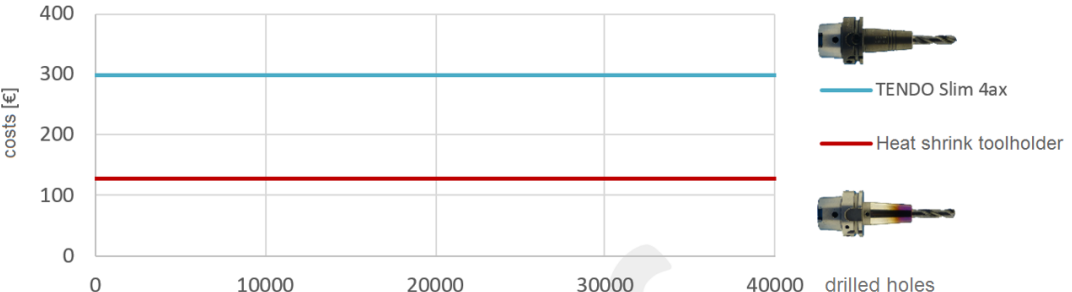
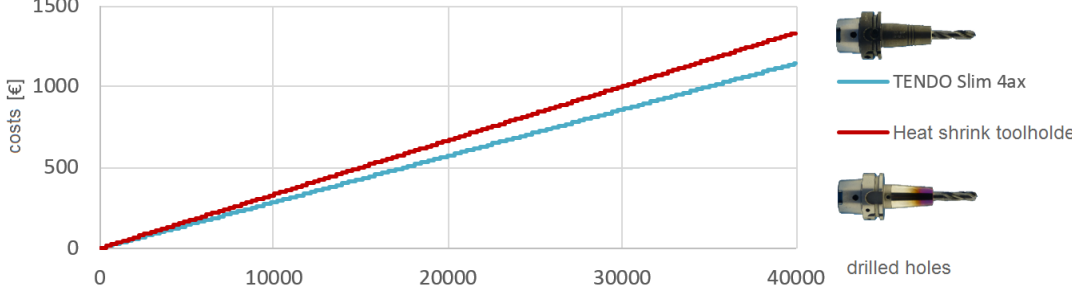
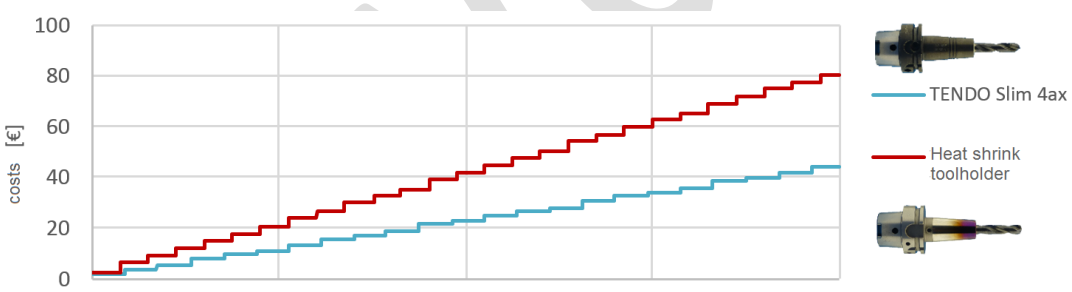
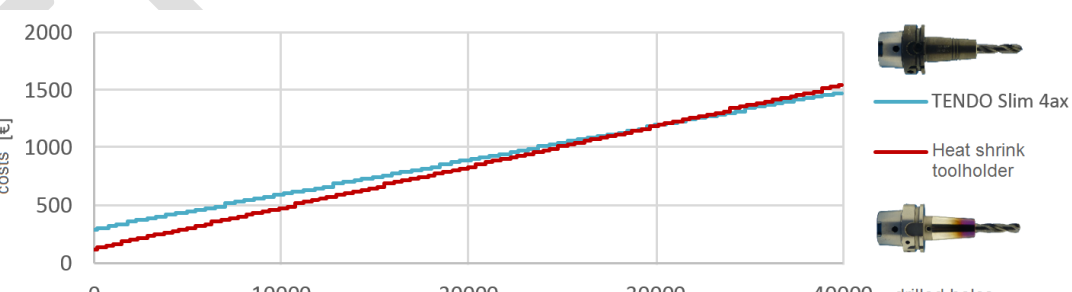
3) Test results

Setup process:	Comparison of setup times during the drilling test:		
	Working step	TENDO Slim 4ax [sec]	Heat shrink chuck [sec]
	Length presetting (±0,1mm)	63	120
	Clamping process	10	20
	If necessary: cool down	0	30
	Measuring	99	99
	Sum:	172	269
Time saving:	The use of hydraulic expansion clamping technology reduces the set-up time for the tools by approx. 36% compared to heat-shrink technology. Already after 160 clamping cycles, the lifetime costs are lower with the TENDO Slim 4ax than with the heat shrink technology.		
Break-Even:	Based on the lifetime of a TENDO Slim 4ax and with a calculated cost rate of 40 €/h, this means a setup cost saving of 4300 €.		

Drilling proces Secondary forces	Measurement of secondary forces (XY plane) during tapping 
Surfaces and chips:	
Boring shape:	
Conclusion Drilling:	With the TENDO Slim 4ax, the secondary forces in the XY plane are halved when drilling, which protects the cutting edges of the drill and results in drill holes with small shape deviations. This effect can be explained by the high concentricity and excellent vibration damping of the hydraulic expansion technology.

Drill wear	Development of wear on the drilling tool		
	Number of bores	TENDO Slim 4ax, Hydraulic expansion chuck 	Heat shrink chuck 
1500			
			
1750			
Conclusion:	Due to strong eruptions, the tool life test with the heat shrink chuck is stopped after 1500 drillings. On the other hand, up to 1750 holes can be drilled with the hydraulic expansion toolholder before breakages can be detected at the transition of the main and secondary cutting edges. In the test, the tool life of the drill can be increased by approx. 17% through the use of hydraulic expansion technology.		

4) Cost consideration

Acquisition of tool holder:	 costs [€] 0 10000 20000 30000 40000 drilled holes TENDO Slim 4ax Heat shrink toolholder
Tool-costs:	 costs [€] 0 10000 20000 30000 40000 drilled holes TENDO Slim 4ax Heat shrink toolholder Due to the 17% increase in tool life due to hydraulic expansion technology, tooling costs are lower.
Set-up costs:	 costs [€] 0 10000 20000 30000 40000 drilled holes TENDO Slim 4ax Heat shrink toolholder In each setup process, 36% of the costs can be saved. In addition, the increased tool life of the TENDO Slim 4ax means that fewer tool changes are necessary.
Total cost:	 costs [€] 0 10000 20000 30000 40000 drilled holes TENDO Slim 4ax Heat shrink toolholder Break-Even: From approx. 30160 drill holes the total costs are lower with the TENDO Slim 4ax than with the heat shrink technology. In the test presented, this corresponds to approx. 21 worn tools in a heat shrink chuck and 18 in a hydraulic expansion chuck.