

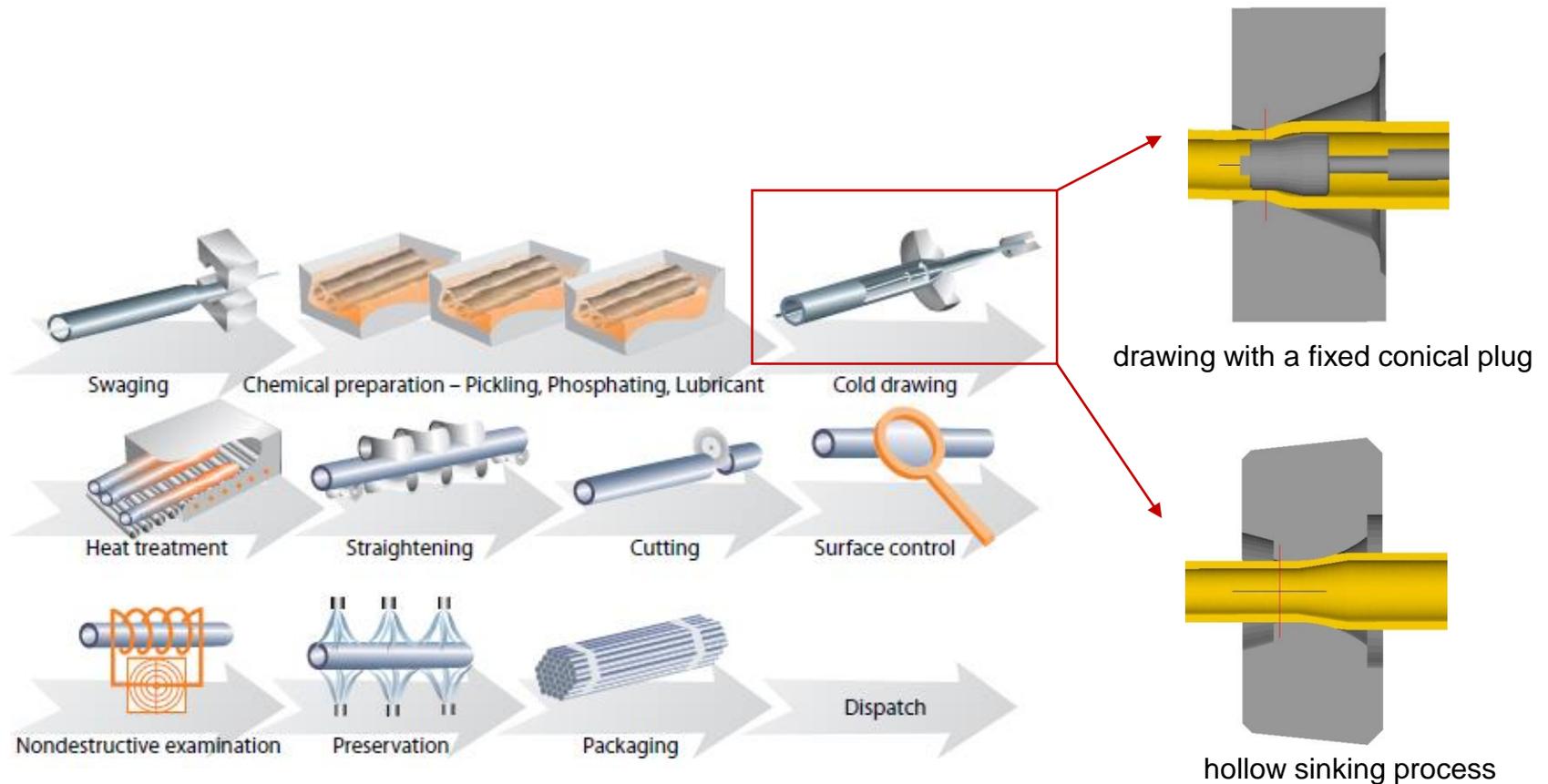


THE INFLUENCE OF TECHNOLOGICAL PARAMETERS FOR THE MANUFACTURE OF PRECISION SEAMLESS TUBES FOR AUTOMOTIVE INDUSTRY

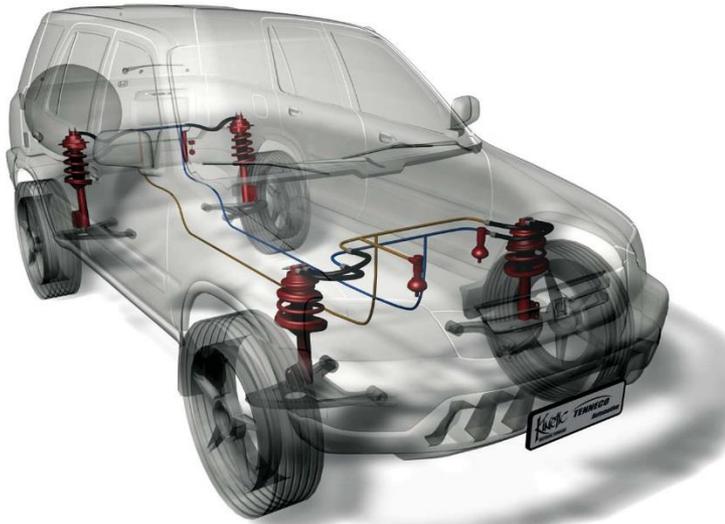
Michal Kán, Martin Ridzoň, Milan Mojžiš, Ján Turňa, Jozef Peterka, Ľudovít Parilák, Jozef Bílik

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- 1. Introduction**
 - 2. Applications of precision seamless tubes for automotive**
 - 3. Measuring the surface temperature**
 - 4. Mechanical properties and dimensional stability**
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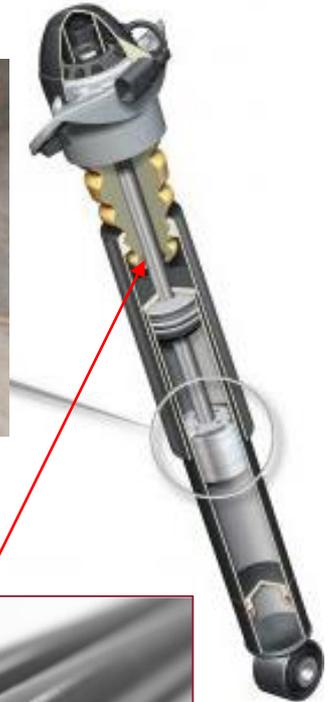
Precision cold drawn tubes in Železiarne Podbrezová



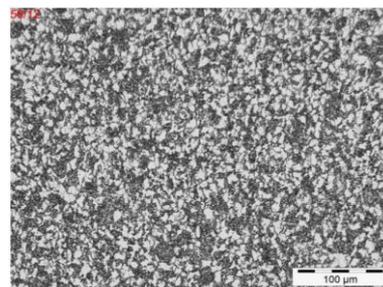
Automotive application seamless steel tubes



MagneRide uses magneto-rheological fluid to provide variable damping capability.



Chemical Composition								
C	Si	Mn	P _{max}	S _{max}	Cr	Ni	Mo	Cu
0.22-0.29	Max .040	0.60	0.025	0.020	0,9	max 0.3	0,15	max 0.3
		-			-		-	
		0.90			1.2		0,30	
Mechanical properties								
Re min [MPa]	R _m [MPa]	A _{min} [%]	KV _{min} [J]	Using temperature				
345	540-690	18	27	400				



Sample microstructure of 25CrMo4 steel tube, cross section



Our pipes are used in automotive shock absorbers

Chemical Composition and mechanical properties of 25CrMo4 Steel grade according to the norm EN 10216-2+A2

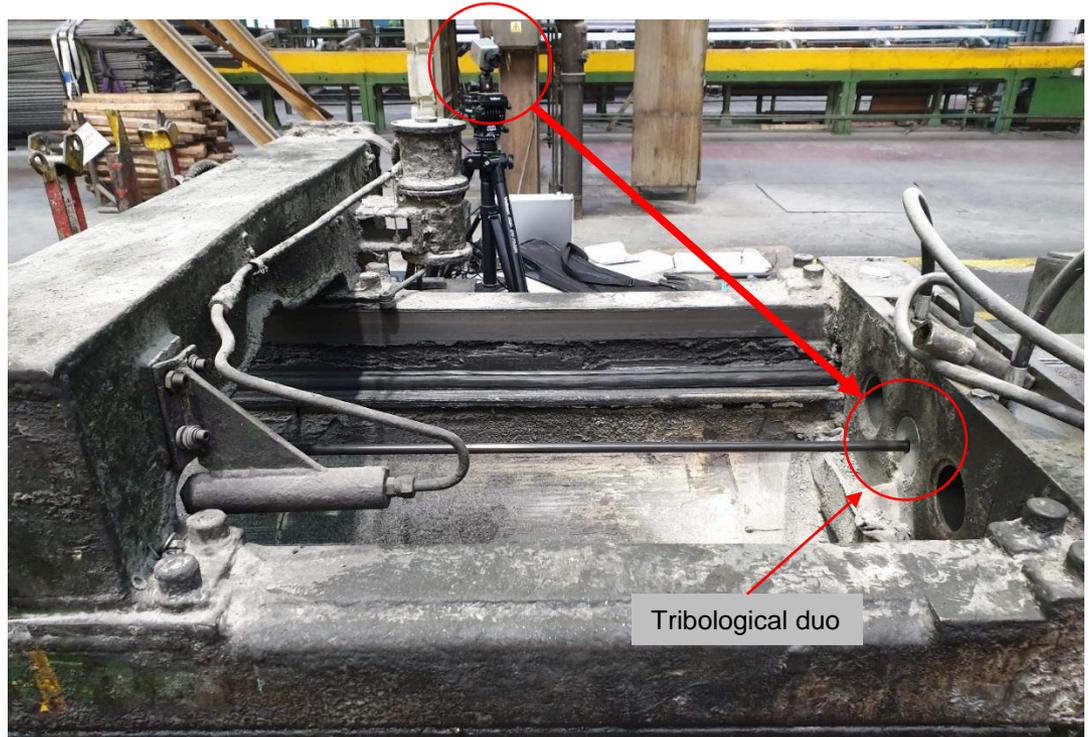


Assembly for measuring the surface temperature



- surface temperature measurements were made by thermal imaging and analyzed by thermo-graphic temperature recording on the tube surface behind the die
- for this experiment used a long-wave thermal imager TIM 200 (wavelength $7.5 \div 14 \mu\text{m}$) was used.
- measure the surface temperature of the tube and the die

The thermoIMAGER TIM 200 from Micro-Epsilon operates by using new bi-spectral technology that combines two images into one



Assembly for measuring the surface temperature of the tube and the working part of the die

Drawing with a fixed conical plug Ø 26x5.25 mm

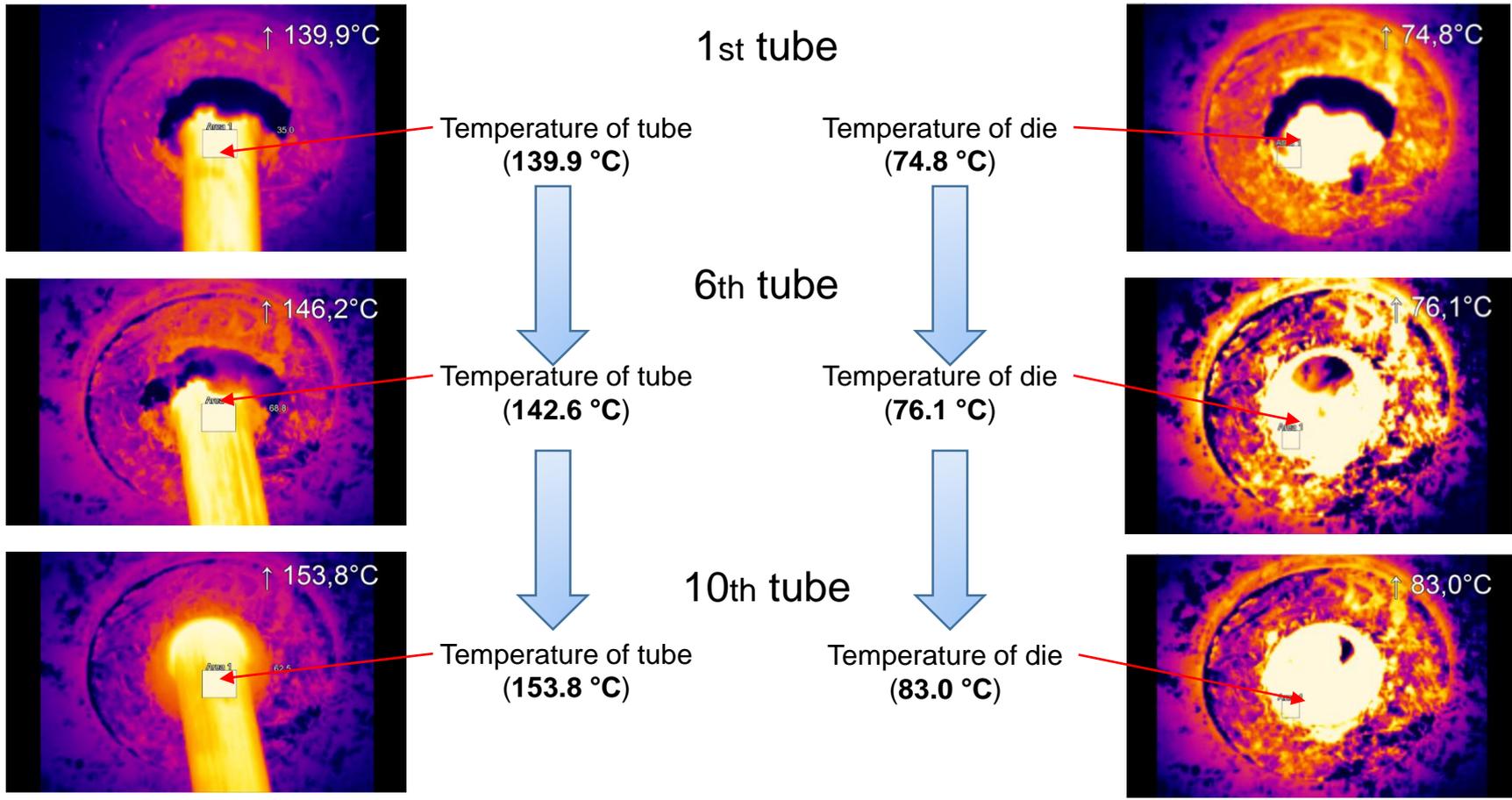
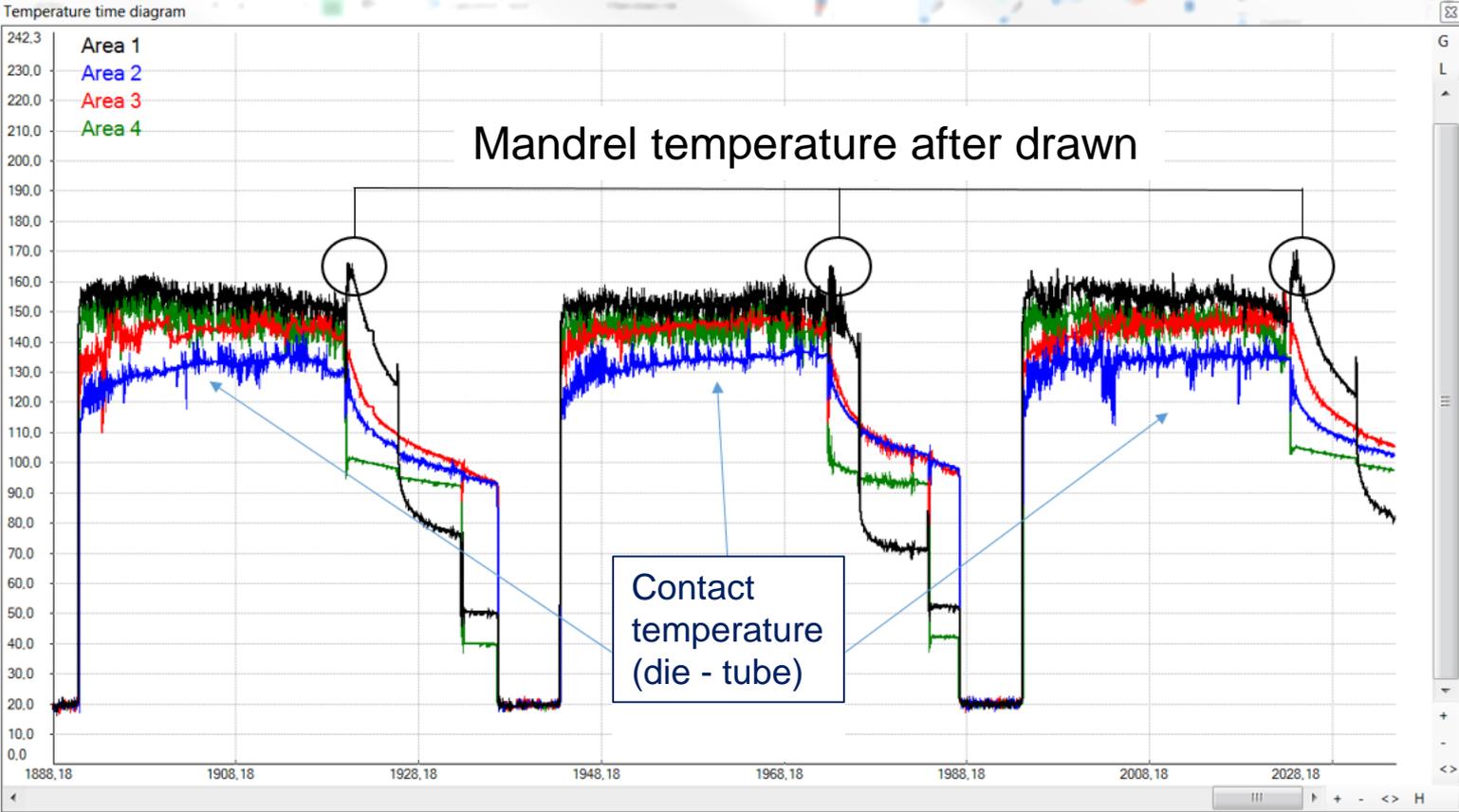
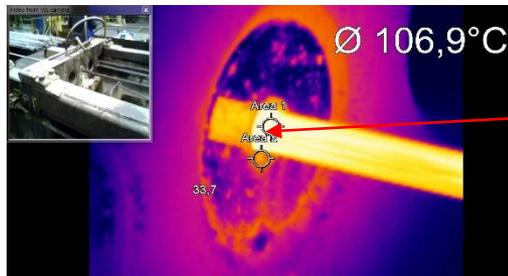


Diagram of surface temperature



Hollow sinking process $\varnothing 17 \times 4.96$ mm

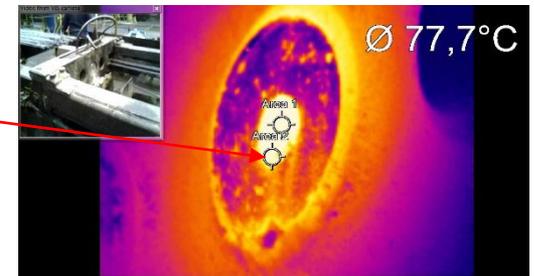


$\varnothing 106,9^{\circ}\text{C}$

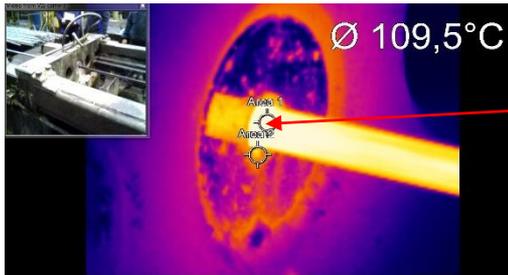
Temperature of tube
($106,9^{\circ}\text{C}$)

1st tube

Temperature of die
($77,7^{\circ}\text{C}$)



$\varnothing 77,7^{\circ}\text{C}$

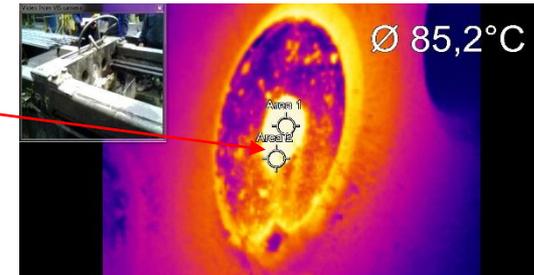


$\varnothing 109,5^{\circ}\text{C}$

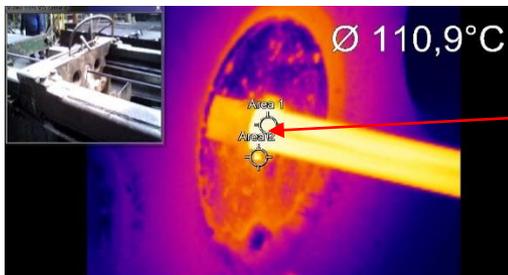
Temperature of tube
($109,5^{\circ}\text{C}$)

7th tube

Temperature of die
($85,2^{\circ}\text{C}$)



$\varnothing 85,2^{\circ}\text{C}$

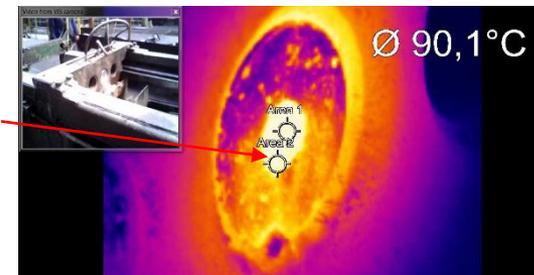


$\varnothing 110,9^{\circ}\text{C}$

Temperature of tube
($110,9^{\circ}\text{C}$)

15th tube

Temperature of die
($90,1^{\circ}\text{C}$)



$\varnothing 90,1^{\circ}\text{C}$

Diagram of surface temperature

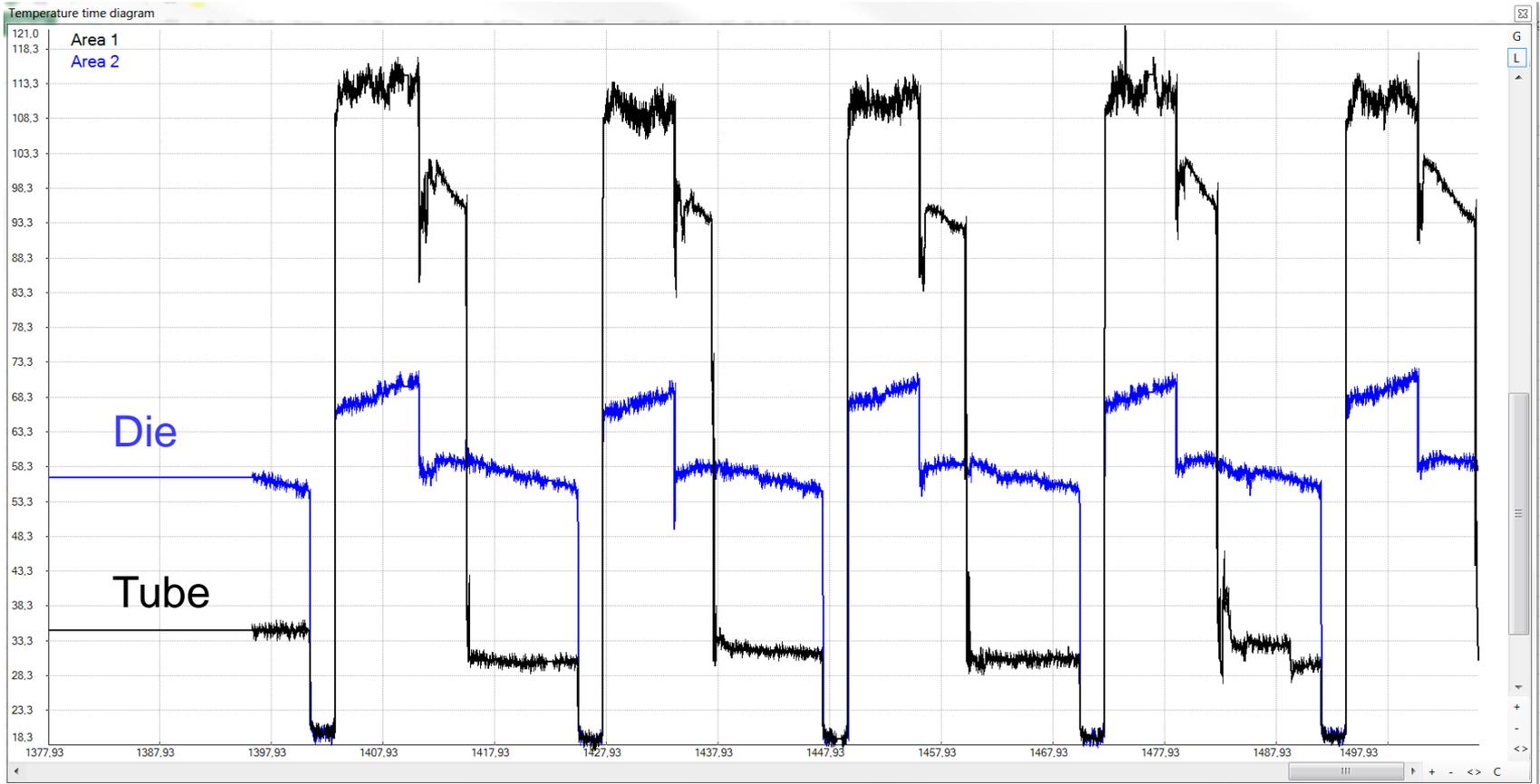


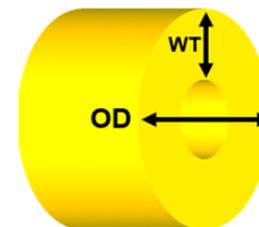
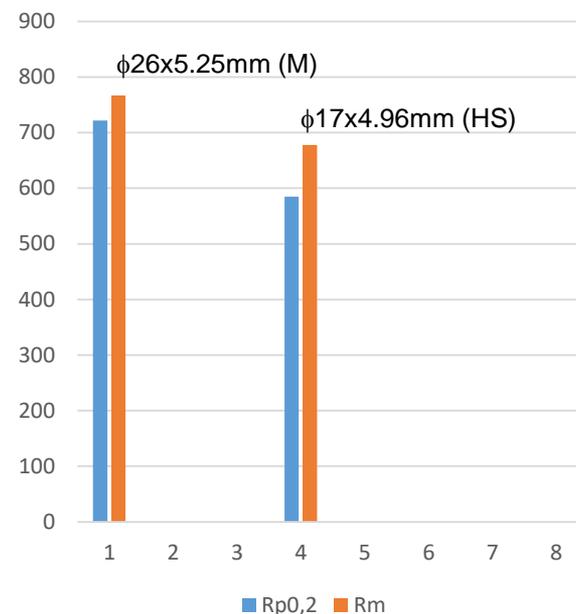
Diagram of surface temperature of tubes and die sample tube No.6 ÷ No.10

Mechanical properties and dimensional stability of tubes

Nr.	Dimension	Rp0,2	Rm	A5	Rp0,2	Rm	A5
1	Ø26 x 5,25	715	761	13	722	767	13
2	Ø26 x 5,25	721	768	13,2			
3	Ø26 x 5,25	729	771	12,5			
1	Ø17 x 4,96	576	670	15,6	585	678	15
2	Ø17 x 4,96	592	679	15,2			
3	Ø17 x 4,96	586	681	14,9			
4	Ø17 x 4,96	585	678	14,3			
5	Ø17 x 4,96	588	684	15,3			

Measured values of tubes

č.	[mm]				E ₀	[mm]					E ₁
	OD ₀	ID ₀	WT _{0min}	WT _{0max}		OD ₁	ID ₁₋₃ bodový	ID ₁₋₂ bodový	WT _{1min}	WT _{1max}	
1.	20	9,82	5,06	5,16	0,98	17	7,11 - 7,13	7,10 - 7,11	4,95	5	0,50
2.	20	9,84	5	5,2	1,96	17	7,11 - 7,13	7,10 - 7,11	4,88	5,05	1,71
3.	20	9,83	5,05	5,16	3,00	17	7,11 - 7,14	7,11 - 7,12	4,92	5,01	1,00
4.	20	9,84	5,02	5,15	1,28	17	7,12 - 7,15	7,11 - 7,13	4,9	5,01	1,11
5.	20	9,83	5,07	5,2	1,27	17	7,11 - 7,14	7,10 - 7,13	4,93	5	0,70
6.	20	9,83	5,05	5,14	0,88	17	7,11 - 7,15	7,11 - 7,14	4,92	4,99	0,71
7.	20	9,81	4,98	5,22	3,00	17	7,11 - 7,14	7,10 - 7,12	4,88	5,07	1,00
8.	20	9,82	4,95	5,18	2,27	17	7,12 - 7,15	7,11 - 7,13	4,88	5,02	1,41
9.	20	9,82	5,07	5,15	0,78	17	7,13 - 7,15	7,13 - 7,15	4,93	4,98	0,50
10.	20	9,81	5,01	5,22	2,05	17	7,12 - 7,15	7,10 - 7,12	4,89	5,01	1,21



Results & Conclusions

Mandrel drawn from dimension $\text{Ø } 32 \times 6 \text{ mm}$ to $\text{Ø } 26 \times 5.25 \text{ mm}$

- total reduction R was 30.17 %
- breaking strength was 767 MPa
- tensile strength is micro-hardness 240 HV 10
- surface temperature of the tube is in interval at 100 - 150 °C
- working temperature of the die was within the average temperature of 77 - 95 °C.

Hollow sinking from dimension $\text{Ø } 20 \times 5.1 \text{ mm}$ to $\text{Ø } 17 \times 4.96 \text{ mm}$

- total reduction was 21.41 %
- breaking strength Rm has dropped to 678 MPa.
- tensile strength is micro-hardness 210 HV 10.
- working temperature of the die is within the average temperature of 75 ÷ 95 °C
- tube surface temperature was in the range of 108 ÷ 121 °C



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