Effects of heat treatment

Name:	Neptun-code:	Lab group.:	Checked by:
Measurement place: BME Department of Materials Science and Engineering, Building G			
Aim of the measurement:			

THROUGH HARDENING DIAMETER

Grossmann-form – numerical method:

Numerical methods:

$$D_{ideal} = 8\sqrt{C} \cdot 1{,}08^{8-n} \prod_{i=1}^{m} (1 + f_{Me_i} Me_i)$$

$$D_{re,water} = \eta D_{id} = 0{,}75 D_{id}$$

$$D_{re,oil} = \eta D_{id} = 0{,}5 D_{id}$$

Me – amount of alloying
i – index
n – grain size factor.
f – multiplying factor

Unalloyed steel (C45)		**Alloyed steel (51CrV4)**		**f**
Element	Amount (%)	Element	Amount (%)	-
C	0,45	**C**	0,5	-
Si	0,32	**Si**	0,25	0,64
Cr	0,4	**Cr**	1,1	2,33
V	-	**V**	0,14	1,73
Mn	0,72	**Mn**	0,90	4,1
Mo	0,006	**Mo**	-	3,14
Ni	0,4	**Ni**	-	0,52
S	0,025	**S**	0,024	-0,62
P	0,011	**P**	0,01	2,83

Grain size number (n):

Unalloyed steel: 9
Alloyed steel: 8

Results:

Material	Ideal diameter	Real diameter in water	Real diameter in oil
Unalloyed steel			
Alloyed steel			

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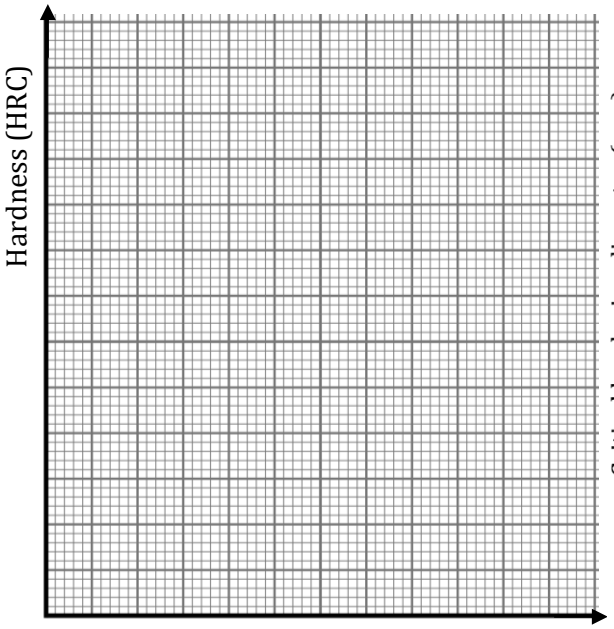
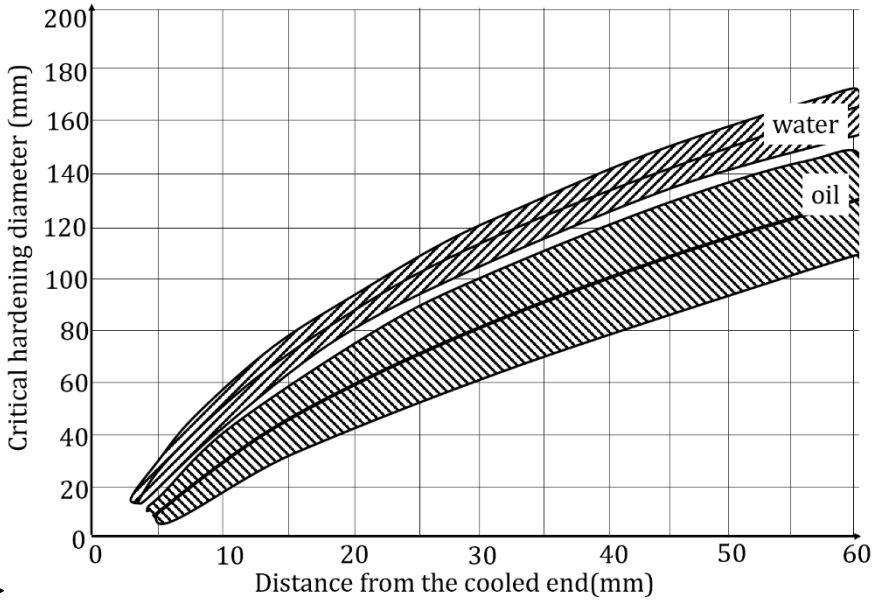
Jominy-test – experimental method:

Test results:

Distance from the cooled end (mm)	Unalloyed steel	Alloyed steel
	Hardness (HRC)	
1,5	*50*	*60*
3	*50*	*60*
5	*48*	*60*
7	*41*	*60*
9	*30*	*60*
11	*28*	*59*
13	*28*	*59*
15	*25*	*59*
20	*25*	*59*
25	*22*	*58*
30	*20*	*57*
35	*20*	*54*
40	*20*	*52*
45	*20*	*50*
50	*20*	*49*



Schematic arrangement of Jominy-test:



The evaluation of the measurement results refers to 100% martensite, which is the highest hardness value.

	Jominy-test		Grossmann	
Material	Real diameter in oil	Real diameter in water	Real diameter in oil	Real diameter in water
Unalloyed steel				
Alloyed steel				

Evaluation and comparison with the results determined by calculation:

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No.	Material	Heat treatment	Hardness (HR_B)	Hardness (HR_C)	Hardness (HV)
1	**C15 (C≈0,15%)**	***Annealed*:** austenized at 850 °C for 20 min, cooled in furnace		---	
2		***Normalised*:** austenized at 850 °C for 20 min, cooled in air		---	
3		***Quenched*:** austenized at 850°C for 20 min, cooled in water		---	
4	**42CrMo4 (C≈0,45%)**	***Annealed*:** austenized at 850 °C for 20 min, cooled in furnace		---	
5		***Normalised*:** austenized at 850 °C for 20 min, cooled in air		---	
6		***Quenched*:** austenized at 850 °C for 20 min, cooled in water	---		
7		***Quenched and tempered:*** quenched + tempered at 400 °C for 20 min, cooled in air	---		
8		***Quenched and tempered:*** quenched + tempered at 600 °C for 20 min, cooled in air	---		
9	**115CrV3 (C≈1,1%)**	***Annealed*:** austenized at 850 °C for 20 min, cooled in furnace		---	
10		***Normalised*:** austenized at 850 °C for 20 min, cooled in air		---	
11		***Quenched*:** austenized at 850 °C for 20 min, cooled in water	---		
12		***Quenched and tempered:*** quenched + tempered at 400 °C for 20 min, cooled in air	---		
13		***Quenched and tempered:*** quenched + tempered at 600 °C for 20 min, cooled in air	---		

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PREPARATION QUESTIONS
(circle the number of the 3 questions you received in the lab)

1. Define the concept of heat treatment!
2. What are the basic heat treatment processes?
3. What is the difference between isothermal and continuous cooling?
4. What information can be read from a continuous cooling diagram?
5. What is the coolant in the case of annealing?
6. What is the coolant in the case of normalizing?
7. What is the coolant in the case of quenching?
8. What are the conditions for hardenability?
9. What is the meaning of the hardened diameter?
10. In what ways can the hardened diameter be determined?

Answers during the lab

IN / OUT	**Signature of lecturer:**