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Quality Improvement in Heat Treatment Based on Necessary Information Exchange

Arnold Horsch

FA 25

Universität Bremen
SFB 570

26th ASM Heat Treating Society Conference 2011, Cincinnati

Co-authors:
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Overview

- Who is AWT
- Main tasks of the AWT research committee (RC 25)
- Motivation and targets of presentation
- Influencing factors of successful heat treatment
- Reasons for necessary information
- Knowledge System
- Conclusion and outlook

Source: SFB 570
AWT FA25 001

Who is AWT?

- German Association for Heat Treatment and Materials Technology
- Founded 1948
- Is a scientific technical association with the aim to advance the theoretical and practical knowledge on material science especially on heat treatment of materials
- The AWT is a member of the AiF, the "Joint Venture for Industrial Research Associations"
- Together with the German State of Bremen the AWT is founder of the Institute for Materials Science (IWT), an interdisciplinary research institute for materials science, process engineering and manufacturing technologies
- AWT has at the moment
  - actually 267 company members
  - more than 500 personal members.

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Who is AWT?

- At the moment 25 research committees of the AWT in cooperation with the Institute of Materials Science (IWT) are working on the
  - current scientific and technological problems of heat treatment
  - materials science
  - process engineering
  - manufacturing technologies

- Currently, 15 local heat treatment chapters provide ample opportunity to exchange information and experience, and also plenty of scope for training
- The chapters meet periodically at various regional locations in Germany

Main tasks of the AWT research committee (RC 25)

- Elaboration of general acceptable technically as well as organizationally possible quality assurance criteria for the heat treatment
- External and internal heat treat shops should obtain more understanding and certainty for their work
- The results should be summarized in a (online) knowledge catalog for heat treatment

- Quality assurance criteria discussed in this presentation:
- Consideration of material information, process information and information about the change of parameters

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Motivation

Insufficient information exchange can lead to avoidable costs for heat treatment:

Costs at the beginning of an order / process:
- **Ask for necessary information**

Costs during and after heat treatment:
- **Surprising results and failures in production**
- **Parts which will fail before reaching lifetime end**
- **Find out reasons, prove if heat treat shop is responsible for the failures**

Goals of presentation

Better understanding of the problems of insufficient or missing information for heat treated components mainly in the area of

- **Necessary raw material information**
- **Necessary delivery information**
- **Necessary information if processes were changed before delivery**

- **Presenting two examples and reasons for necessary information**
- **Introducing a knowledge system to collect necessary information and their reasons**

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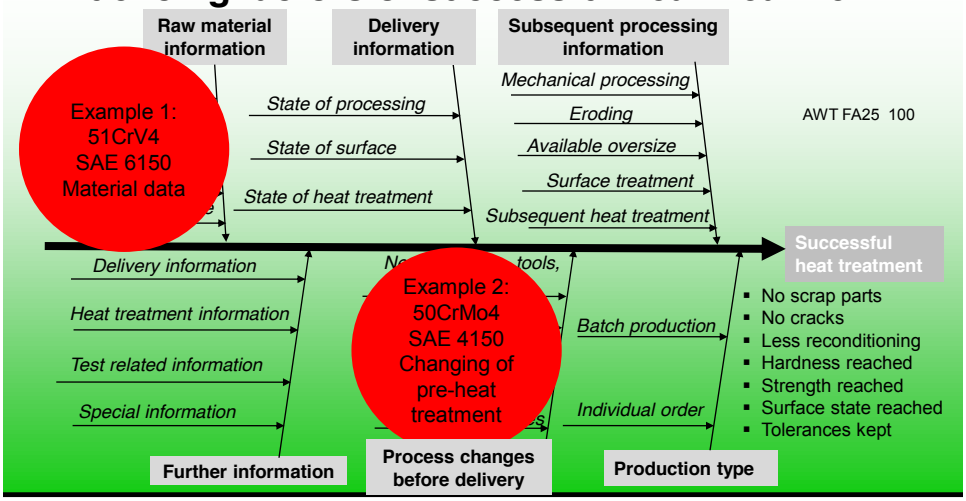
Influencing factors of successful heat treatment



Reasons for necessary information Material data - 51CrV4 (SAE 6150)

Example:
51CrV4

Information:
No availability of necessary material data information

What is shown:
How much different information and interpretations are possible about chemical composition, hardenability and tempering behavior

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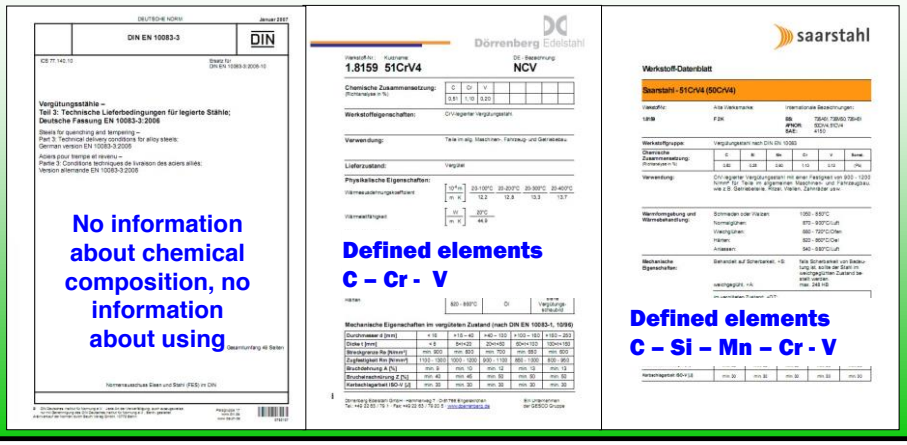
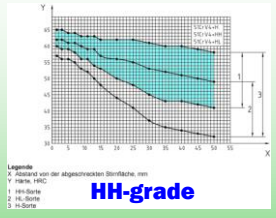
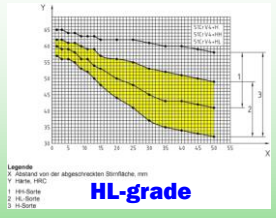
Rationales for necessary material information – chemical composition SAE 6150 (51CrV4)



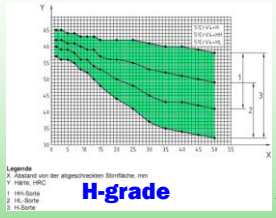
Reasons for necessary Material information – hardenability, tempering behavior - 51CrV4



HH-grade



HL-grade



H-grade

Source: DIN EN 10083-3:2006

51CrV4/1.8159		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	mm
H max	HH max	65	65	64	64	63	63	63	62	62	62	61	60	60	59	58	HRC
	HH min	60	59	59	58	56	56	54	53	50	48	45	43	43	42	41	HRC
	HL max	62	62	61	61	60	59	59	57	56	55	53	52	51	50	49	HRC
H min	HL min	57	56	56	55	53	52	50	48	44	41	37	35	34	33	32	HRC
HH max - HL min.	Δ	8	9	8	9	10	11	13	14	18	21	24	25	26	26	26	HRC

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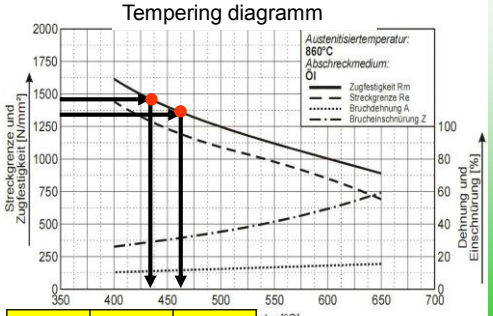
Reasons for necessary Material information – different material numbers – SAE 6150

SAE 6150 / 1.8159 Tempered/Spring Steel

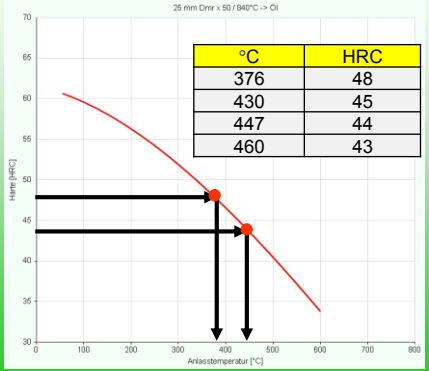
Tempering diagramm



°C	R_m	HRC
430	1490	48
460	1391	44

Source: Dörrenberg

SAE 6150 / **1.2241** Toolsteel



°C	HRC
376	48
430	45
447	44
460	43

Source: StahlWissen NaviMat

Reasons for necessary information
Process changes – 50CrMo4 (SAE 4150)

Example: 50CrMo4
Information: No information about process changes
Customer specification: Hardness > 700 HV
Problem: Hardness is not reached
Process description:

- Customer changed delivery state – former tempered – now +AC (annealed on globular cementite)
- Superfine carbides from hardening and tempering (only 500°C) have changed into thick balls of carbides

What is shown:

- New state is softer than the older one
- If reaching the same hardness, more energy for the new state is needed

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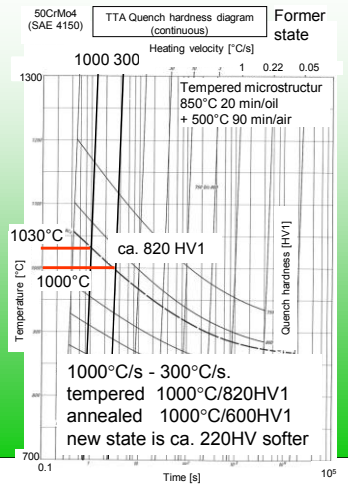
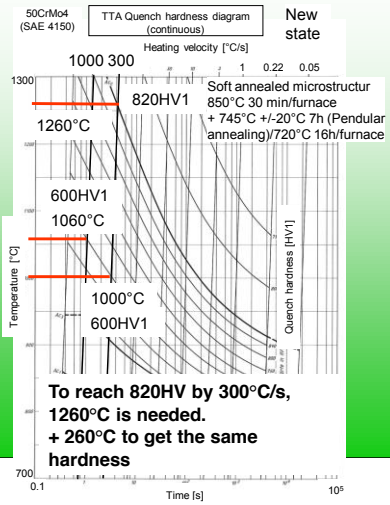
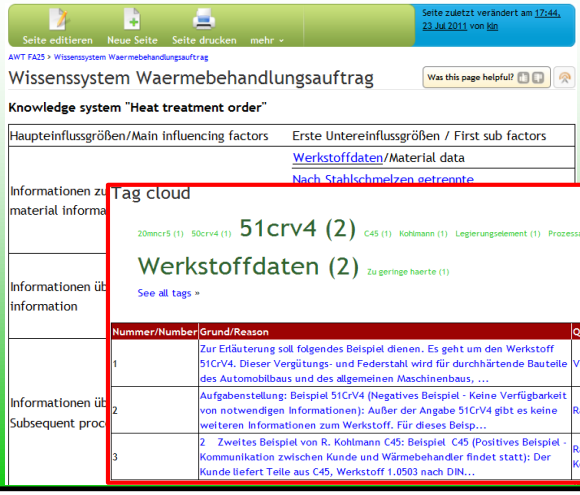
Reasons for necessary information
Process changes – SAE 4150 (50CrMo4 / 1.7228)





Source: Atlas Atlas zur Wärmebehandlung der Stähle Band 3

Knowledge System



- Arranged on the basis of the influencing factors
- Implemented by an open source wiki platform

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Conclusion

- **Point out the necessity of information exchange**
- **Argue for a better understanding to reach a win-win situation**
- **Present influencing factors of successful heat treatment**
- **Illustrate two examples and reasons of necessary information exchange**
- **Introduce a knowledge system to collect necessary information and their reasons**

Outlook and Future work

- **Publish and disseminate the need of useful information exchange in further publications and on further conferences**
- **Extend the knowledge system by further examples and reasons for necessary information**
- **Prepare the knowledge system to open it for the public**

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Thanks for your attention