Computer Aided Case Hardening Engineering

Prof. Dr. habil. Jürgen Gegner

Short Course: 25 August 2013; 9h – 17h;

Hyatt Regency Mission Bay Spa & Marina, San Diego, California, USA

Case hardening is the most important heat treatment of steel. The surface layer of a low alloyed grade is enriched with carbon by in-diffusion in the temperature range of austenite. Subsequent quenching thus results in martensite of high hardness, fatigue strength and wear resistance in the edge zone that is combined with the good shock load capacity from the tough core microstructure. The service performance of the produced parts and the economic efficiency of the heat treatment depend on an excellent process quality. The course introduces in a compact manner the fundamentals and application of case hardening engineering (CHE) with expert software. **Learn more about the systematic procedure of process analysis and simulation to improve your heat treatment results!** Computer aided case hardening engineering (CA-CHE) involves the accurate material science founded mathematical prediction, experimentally verified calibration and parameter study based planning of the heat treatment. Continuous monitoring finally ensures the stability of tailored processes. The applied methodology is discussed in detail. The advanced *SimCarb* simulation tool, which consists of three interacting Windows® programs, provides deep insight into case hardening of steels and discloses optimization potentials in terms of quality, productivity, and sustainability, i.e. energy as well as resource efficiency.

Who Should Attend?

Researchers and practitioners from academia and industry dealing on a material science level with experiment or simulation based analysis and the holistic optimization of carburizing case hardening processes will benefit from this course.

Course Outline

Based on state-of-the-art technologies and innovative knowledge, the course provides a unique introduction to the principles of computer aided case hardening engineering. The scope covers both the prerequisites on the measurement side and the various applications of expert software. The use of the three-part stand-alone Windows® *SimCarb* program package for the numerical simulation of case hardening is described. For the new important aspect of alloy dependent carbon diffusion coefficients in the austenite of case hardening steels, a detailed analysis of the significant influence on the heat treatment results is presented. This study is based on real-process two-step boost-diffuse carburizing experiments, *SimCarb* simulations and a metal physics model. The implemented empirical and thermophysical approaches to predict the quenching result are explained and applied. Experimentally evaluated carbon dependent diminution factors of martensite and Hollomon-Jaffe parameters, measured for the first time in the temperature range of

150 to 200 °C relevant to case hardening, are available to calculate the tempering hardness. All simulation results are compared with experimental findings.

Topics Overview

- First Introduction to case hardening engineering and outline of the course
- Fundamentals and technology of case hardening of steel
- Process and material measurement techniques
- Experimental method to determine the diffusivity of carbon in austenite of steels
- Modeling and mathematics of case hardening simulation
- Computer aided carburizing and the basic *SimCarb* module
- Alloy dependent carbon diffusion coefficients and the extension module *SimCarb Diffusivity*
- Computer aided quenching/tempering and the hardening module *SimCarb QuenchTemp*
- Practical offline and online computer aided case hardening engineering
- Future work, final discussion and conclusions

Course Materials

The participants will receive:

- Handout of lecture slides
- Comprehensive collection of recent papers on case hardening engineering
- Certificate of participation
- Lunch and refreshments

Course Instructor: Prof. Dr. habil. Jürgen Gegner

Prof. Dr. habil. Jürgen Gegner from the Institute of Material Science of the University of Siegen, Germany, has more than 20 years of experience in diffusion and heat treatment of metal alloys. He started his work on case hardening of steel in 2000. In the framework of his habilitation research completed in 2005, he developed a high precision measurement technique of carbon depth profiles, an experimental method for the determination of carbon diffusion coefficients in steels, and an advanced metal physics model of carburizing. His *SimCarb* software was launched in 2006. By putting together all aspects of his work systematically, he introduced a new concept of holistic process optimization and named it *Case Hardening Engineering* in 2009. Prof. Gegner has published more than 150 technical papers and 4 books and is the inventor of 17 patents. Since 2007, he heads the internationally leading German Research Committee for Residual Stresses.

REGISTRATION: http://www.flogen.org/MMM2013/registration.php