27th Heat Treating Society Conference 2013

Indianapolis, Indiana, USA
16-18 September 2013

Editor:

B. Lynn Ferguson

Contents

Organizing Committee

Preface

Atmospheres

Advanced On-Site Hydrogen Generation Provides Enhanced Capabilities
Dave Wolff¹, Randy Gorman², Mike Wood², and Adam Herringshaw²
(1) Proton OnSite, Wallingford, CT, USA
(2) Riverhawk Company, New Hartford, NY, USA

Case Hardening Using Nitrogen-Based Atmospheres
Zbigniew Zurecki¹ and Karl-Michael Winter²
(1) Air Products & Chemicals, Inc., Allentown, PA, USA
(2) Process-Electronic GmbH, Heiningen, Germany

Understanding Atmosphere in Carburizing Applications Using Simulation and Real-Time Carbon Diffusion
Jim Oakes, Super Systems, Inc., Cincinnati, OH, USA

Brazing

Dynamic Fluoride Ion Cleaning as A Pre-Braze Process
Robert E. Kornfeld
Hi-Tech Furnace Systems, Inc., Shelby Township, MI, USA

Welding Behavior of Molybdenum Tubing With and Without Lanthanum Oxide
Todd Leonhardt, Rhenium Alloys Inc., North Ridgeville, OH, USA

Cryogenics

Comparisons of Deep Cryogenically Treated Brake Rotors versus Untreated Rotors Using Laboratory Tests and Practical Tests
Frederick (Rick) J. Diekman
Controlled Thermal Processing, Inc., Antioch, IL, USA

Cryogenic Non Destructive Testing (NDT) and Material Treatment
Cryogenic Transition Detection
Victor F. Sloan
Victor Aviation Service, Inc., Palo Alto, CA, USA

New Frontiers in Metal Treatment—Deep CryogenicTreating of Metals and Other Materials
Rozalia Papp, Air Liquide U.S. LP, Houston, TX, USA
Emerging Technologies

Austempering versus Quenching and Tempering—Impact Behavior of SAE 4140 and SAE O1 Steels

Lauralice de C. F. Canale1, José E. Nucci1, Jan Vatavuk2, and George E. Totten3
(1) University of São Paulo, São Carlos, SP, Brazil
(2) Universidade Presbiteriana Mackenzie, São Paulo, SP, Brazil
(3) Portland State University, Portland, OR, USA

Calculate Allowable Stress—Quit Factor of Safety

Nori VSN Murthy, Independent Researcher, India

Delta Ferrite in Heat Treated Bolts—Characterization and Consequences

Robson Bussoloti1, George E. Totten2, and Lauralice de C. F. Canale1
(1) Escola de Engenharia de São Carlos, São Carlos, SP, Brazil
(2) Portland State University, Portland, OR, USA

Is There A Viable Alternative to Refractory Ceramic Fibers?

Chris Johnson and William Patton
Thermal Ceramics business of Morgan Advanced Materials, Augusta, GA, USA

Self-Heating of Powder Materials during High-Temperature Drying

Muhammad M. Rafique Qureshi
Chilworth Technology, Inc., Princeton, NJ, USA

The Effects of Tempering on The Hardness Profiles in Carburized Steels

Lei Zhang, Xiaoqing Cai, Mei Yang, and Richard D. Sisson, Jr
Worcester Polytechnic Institute, Worcester, MA, USA

Equipment Innovations

Batch Integral Quench Furnace Innovations—Heating, Quenching, Automation

Ralph P. Poor, Surface Combustion, Inc., Maumee, OH, USA

Bright Tempering—Achieving High Quality Appearance During Tempering

Aymeric Goldsteinas and Craig Moller, Ipsen, Inc., Cherry Valley, IL, USA

Dual Processes’ Normalize and Anneal Temperature Uniformities in Box Furnaces

William J. Bernard, III, Surface Combustion, Inc., Maumee, OH, USA

Heat Treating with Diode Lasers

Mark Daichendt1 and Wolfgang Todt2
(1) Laserline GmbH, Muelheim-Kaerlich, Germany
(2) Laserline, Inc., Santa Clara, CA, USA
Investigation on Improving The Life of Immersion Burner Tubes in Industrial Furnaces
R. Krishna Sabareesh, P. Ragupathy, Sudhir Malavade, Shishir Desai, Rajesh Mohite, Devendra Patil, Suresh Gulavani, and Joseph Lopes
Tata Steel Global Wire Division, Maharashtra, India

Monitoring, Understanding, and Reducing Energy in Heat Treat
Michael A. Pershing, David M. Miller, and Kinyon Gorton
Caterpillar Inc., East Peoria, IL, USA

Trial to Determine The Suitability of The New Heat Treat Facility at Corry Forge Company for Processing Blowout Preventer Bodies
Jared C. Alexander, Corry Forge Company, Corry, PA, USA

Global Issues

Environmental Friendly Controlled Cooling of Forgings—Potential Replacement to Normalizing and Iso-Annealing
Udayan Pathak and Vikas Shingade
Tata Motors Limited Pune, India

Teri Buck¹, Suranjeeta Dhar², Medina Kaknjo², Philip Mikula³
(1) TRW Automotive, Livonia, MI, USA
(2) Ford Motor Company, Allen Park, MI, USA
(3) P.C. Mikula Consulting LLC, Grosse Point Woods, MI, USA

Web Based Wireless Heat Treating Services
Tom Decker¹ and Eric Sjerve²
(1) Thermal Technologies International Inc., Claremore, OK, USA
(2) IRISNDT Corp., Alberta, Canada

Induction Heating

Control Systems for Induction Heat Treating—The Obsolete and Newest Designs
Fred R. Specht
Ajax Tocco Magnethermic Corp., Warren, OH, USA

Enhancing Induction Coil Reliability
K. Kreter, R. Goldstein, C. Yakey, and V. Nemkov
Fluxtrol Inc., Auburn Hills, MI, USA

In-Line Induction Heat Treating of Tube, Pip, and Bar Products
Lesley D. Frame, Thermatool Corp., East Haven, CT, USA
Influence of Geometric Parameters on Residual Stress in Hollow Cylindrical Parts Subjected to Induction Surface Hardening

Dmitry Ivanov, Leif Markegård, and John Inge Asperheim
EFD Induction a.s., Skien, Norway

Innovations in Soft Magnetic Composites and Their Applications in Induction Systems

R. Ruffini, N. Vyshinskaya, V. Nemkov, R. Goldstein, and C.J. Yakey
Fluxtrol Inc., Auburn Hills, MI, USA

Novel User-Friendly Computer Modeling Software for Induction Heating and Induction Heat Treating

Valery Rudnev, Inductoheat, Inc., Madison Heights, MI, USA

Effect of Spray Quenching Rate on Distortion and Residual Stresses during Induction Hardening of A Full-Float Truck Axle

Zhichao (Charlie) Li¹, B. Lynn Ferguson¹, Valentin Nemkov², Robert Goldstein², John Jackowski², and Greg Fett³
(1) Dante Software, Cleveland, OH, USA
(2) Fluxtrol, Inc., Auburn Hills, MI, USA
(3) Dana Corporation, Maumee, OH, USA

Process Innovation to Eliminate Cracking Problems in Large Diameter Parts with Nonuniform Wall Thickness

Zhichao (Charlie) Li and B. Lynn Ferguson
Dante Software, Cleveland, OH, USA

Materials Selection for Induction Hardening Processes

Fred R. Specht, Ajax-Tocco-Magnethermic, Warren, OH, USA

Masters Series

The Jominy End Quench and Effect of Austenitizing on The Hardenability and Performance of Quenched Steels

George Krauss, Colorado School of Mines, Golden, CO, USA

Nitriding & Carburizing

Effect of Plasma Nitriding on Fatigue and Wear Behavior of AISI4330 Low Alloy Steel

Jagdish Sherkar¹, Rajkumar Singh¹, Raju Kadam¹, Ganesh Jawale¹, and Ram Chandra Prasad²,
(1) Bharat Forge Ltd., Maharashtra State, India
(2) Indian Institute of Technology Bombay, Maharashtra State, India

A Practical Approach to Controlling Gas Nitriding and Ferritic Nitrocarburizing (FNC) Processes

Stephen Thompson, Super Systems, Inc., Cincinnati, OH, USA
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Investigation of Case-Core Separation in Carburized Steels</td>
<td>144</td>
</tr>
<tr>
<td>Sarah Byrnes, Claire A. Campbell, and Timothy De Hennis</td>
<td></td>
</tr>
<tr>
<td>The Boeing Company, Philadelphia, PA, USA</td>
<td></td>
</tr>
<tr>
<td>Analysis and Experience using Process Modeling for Developing New and Corrective Heat Treat</td>
<td>154</td>
</tr>
<tr>
<td>Schedules for Deep Case Carburizing</td>
<td></td>
</tr>
<tr>
<td>Andrew M. Freborg and B. Lynn Ferguson</td>
<td></td>
</tr>
<tr>
<td>Dante Software, Cleveland, OH, USA</td>
<td></td>
</tr>
<tr>
<td>Influence of Steel Surface Roughness on The Nitrogen Uptake during Gaseous Nitriding Process</td>
<td>158</td>
</tr>
<tr>
<td>D. Koshel and J. Kalucki, Nitrex Metal Inc., QC, Canada</td>
<td></td>
</tr>
<tr>
<td>Modeling The Carbonitriding of Steel</td>
<td>162</td>
</tr>
<tr>
<td>Mei Yang, Xiaolan Wang, Yuan Xu, Liang He, and Richard D. Sisson Jr.</td>
<td></td>
</tr>
<tr>
<td>Worcester Polytechnic Institute, Worcester, MA, USA</td>
<td></td>
</tr>
<tr>
<td>Modeling The Gas Nitriding Process for Steels</td>
<td>166</td>
</tr>
<tr>
<td>Worcester Polytechnic Institute, Worcester, MA, USA</td>
<td></td>
</tr>
<tr>
<td>Ferritic Nitrocarburizing Processes and Applications</td>
<td>170</td>
</tr>
<tr>
<td>Benjamin T. Bernard, Surface Combustion, Inc., Maumee, OH, USA</td>
<td></td>
</tr>
<tr>
<td>Numerical Simulation Advances in Gear Manufacturing Processes</td>
<td>173</td>
</tr>
<tr>
<td>James B. Miller, Ravi Shankar, and John Walters</td>
<td></td>
</tr>
<tr>
<td>Scientific Forming Technologies Corp., Columbus, OH, USA</td>
<td></td>
</tr>
<tr>
<td>Processes and Applications</td>
<td></td>
</tr>
<tr>
<td>Advances in Eddy Current Verification of Heat Treat Processes</td>
<td>177</td>
</tr>
<tr>
<td>Dan DeVries, Criterion NDT, Auburn, WA, USA</td>
<td></td>
</tr>
<tr>
<td>Banding Effect on The Hardenability of AISI 4340 Steel Bar—Case Study</td>
<td>181</td>
</tr>
<tr>
<td>Jan Vatavuk⁴, Antonio Augusto Couto⁴, Silvio André de Lima Pereira⁵,</td>
<td></td>
</tr>
<tr>
<td>Silas Aragão de Sousa⁵, and Lauralice de C. F. Canale⁶</td>
<td></td>
</tr>
<tr>
<td>(1) Universidade Presbiteriana Mackenzie, SP, Brasil</td>
<td></td>
</tr>
<tr>
<td>(2) Mahle Metal Leve S.A. Centro Tecnológico, SP, Brasil</td>
<td></td>
</tr>
<tr>
<td>(3) Escola de Engenharia de São Carlos, SP, Brasil</td>
<td></td>
</tr>
<tr>
<td>Evaluation of A New Alloy (PremoMet) for Seamless Rings Application</td>
<td>185</td>
</tr>
<tr>
<td>Octavio Covarrubias-Alvarado⁴, Arisbeth Sias-Chacon⁴, and Alberto Perez-Unzueta⁵</td>
<td></td>
</tr>
<tr>
<td>(1) Frisa Forjados SA de CV, Nuevo Leon, Mexico</td>
<td></td>
</tr>
<tr>
<td>(2) Universidad Autonoma de Nuevo Leon, Nuevo Leon, Mexico</td>
<td></td>
</tr>
</tbody>
</table>
Improvement in Mechanical Properties of Austempered Ductile Iron (ADI) by Cryogenic Treatment

Susil K. Putatunda¹, Saranya Panneerselvam¹, Codrick J Martis¹, Frederick Diekman², and Rozalia Papp³

1 Wayne State University, Detroit, MI, USA
2 Controlled Thermal Processing Inc., Park City, IL, USA
3 Air Liquide US LP, Countryside, IL, USA

Improving New and Existing Heat Treat Processes

Joe Clarke, Invensys Eurotherm, Ashburn, VA, USA

Localized Surface Modification on 1018 Low Carbon Steel by Electrolytic Plasma Process and its Impact on Corrosion Behavior

Jiandong Liang, Shengmin Guo, and Muhammad A. Wahab

Modeling Precipitation Kinetics during Heat Treatment with Calphad-Based Tools

Kaisheng Wu¹, Paul Mason¹, Gustaf Sterner², and Qing Chen²

1 Thermo-Calc Software Inc., McMurray, PA, USA
2 Thermo-Calc Software AB, Stockholm, Sweden

Novel Method of Removal and Tightening of Bolts

Tom Decker¹ and Eric Sjerve²

1 Thermal Technologies International Inc., Claremore, OK, USA
2 IRISNDT Corp., AB, Canada

Protective Atmospheres, Measurement Technologies, and Troubleshooting Tools

Damian Bratcher, Super Systems, Inc., Cincinnati, OH, USA

How important is Accuracy in Today’s World! Technology and Improvements in Analog and Digital Control

Steve Miller, Invensys Eurotherm, Ashburn, VA, USA

Technology to Connect and Enhancements to Improve

Chris Mooney, Invensys Eurotherm, Ashburn, VA, USA

Quenching and Cooling

Characterizing Water Quenching Systems with A Quench Probe

B. Lynn Ferguson, Zhichao Li, and Andrew M. Freborg
Deformation Control Technology, Inc., Cleveland, OH, USA

Agitated Quench Heat Transfer–An Experimental Characterization

Andrew L. Banka, William H. Newsome, and Jeffrey D. Franklin
Airflow Sciences Corp., Livonia, MI, USA

Comparison of Nozzle versus Impeller Agitation in Quench Systems

Andrew L. Banka and Tiffany M. Lee
Airflow Sciences Corp., Livonia, MI, USA
Design and Optimization of Fixture for High Pressure Gas Quenching of Transmission Components.................................................................236
  Junsheng Wang¹, Xuming Su¹, Mei Li¹, Ronald Lucas², and William Dowling²
  (1) Ford Research and Advanced Engineering Lab, Dearborn, MI, USA
  (2) Powertrain Manufacturing Engineering, Livonia, MI, USA

Development of Quench Tank Agitation Design Using CFD Modeling.................................................................241
  Andrew L. Banka¹, John D. Nitz¹, and Jeffery Nystrom²
  (1) Airflow Sciences Corp., Livonia, MI, USA
  (2) Corry Forge Company, Corry, PA, USA

Fixture Hardening of Large Components..................................................................................................................245
  Gerd Müller-Laessig
  HESS GmbH & Co KG, Lampertheim, Germany

Flexible Controlled Atmosphere Hardening Processes Utilizing Atmosphere Furnaces and Salt Quenching Systems.................................................................249
  Charles Hartwig¹ and John W. Gottschalk²
  (1) Therm-Tech of Waukesha, Inc., Waukesha, WI, USA
  (2) Surface Combustion, Inc., Maumee, OH, USA

Numerical Investigation of Immersion Quenching Process for Cast Aluminum Parts Using An Eulerian Multi-Fluid Approach.................................................................251
  R. Kopun¹, D. Greif¹, Z. Kovačič¹, and R. Tatschl²
  (1) AVL – Advance Simulation Technology d.o.o., Maribor, Slovenia
  (2) AVL List GmBH, Graz, Austria

The Mechanism of Quench Oil Oxidation..................................................................................................................255
  D. Scott MacKenzie
  Houghton International, Valley Forge, PA, USA

Progress on The Development of A Comprehensive Heat Transfer Model for Industrial Liquid Quenching Processes.................................................................259
  Jeffrey Franklin, Andrew Banka, and William Newsome
  Airflow Sciences Corp., Livonia, MI, USA

Redefining Quenching Technology..................................................................................................................265
  Aymeric Goldsteinas and Jake Hamid, Ipsen, Inc., Cherry Valley, IL, USA

Some New Phenomena Discovered During Immersion of Steel Parts Into Liquid Quenchants.................................................................269
  Nikolai I. Kobasko, IQ Technologies Inc., Kyiv, Ukraine

Vacuum Technology

In Situ Oxidation of Steels as an Effective and Economical Pretreatment for Uniform and Consistent Vacuum Gas Nitriding Results.................................................................N/A
  Trevor M. Jones, Solar Atmospheres Inc., Souderton, PA, USA
Modeling Gas and Low Pressure Carburizing of Steel
Xiaolan Wang, Mei Yang, Yingying Wei, Lei Zhang,
Liang He, and Richard D. Sisson, Jr.
Worcester Polytechnic Institute, Worcester, MA, USA

Modern Heat Treatment of Large Dies in HPGQ Vacuum Furnaces
Maciej Korecki¹, Jozef Olejnik¹, Piotr Kula², Emilia Wolowiec²
(1) SECO/Warwick S.A., Swiebodzin, Poland
(2) Lodz University of Technology, Lodz, Poland

Synchronized Heat Treatment for Totally Integrated Manufacturing-Lines
Volker Heuer and Klaus Loeser
ALD Vacuum Technologies GmbH, Hanau, Germany

Vacuum and Atmosphere Heat Treating Overview
Josh McCaughey, C.I. Hayes, Cranston, RI, USA

Considering Emissivity Factors of A Workload When Projecting Heating Rates in a Vacuum Furnace
Real Fradette and Trevor Jones
Solar Manufacturing, Souderton, PA, USA

Vacuum Tempering at Higher Pressures
Ralph P. Poor, Surface Combustion, Inc., Maumee, OH, USA

Welding Behavior of Molybdenum Tubing with and without Lanthanum Oxide
Todd Leonhardt

Trial to Determine the Suitability of the New Heat Treat Facility at Corry Forge Company for Processing Blowout Preventer Bodies
Jared C. Alexander

In Situ Oxidation of Steels as an Effective and Economical Pretreatment for Uniform and Consistent Vacuum Gas Nitriding Results
Trevor M. Jones

Author Index