Effect of Steel Manufacturing Processes on the Quality of Bearing Steels

J. J. C. Hoo
editor

ASTM STP 987
Effect of Steel Manufacturing Processes on the Quality of Bearing Steels

J. J. C. Hoo, editor
Effect of steel manufacturing processes on the quality of bearing steels/J. J. C. Hoo, editor.

(Stp; 987)

Papers from the Symposium on Effect of Steel Manufacturing Processes on the Quality of Bearing Steels, held at Phoenix, Ariz., Nov. 4-6, 1986 and sponsored by the Subcommittee A01.28 on Bearing Steels of the Committee on A01 on Steel, Stainless Steel, and Related Alloys.

Includes bibliographies and indexes.

"ASTM publication code number (PCN) 04-987000-02."

ISBN 0-8031-0999-7


TA473.E42  1988

620.1'73—dc19

88-19876

CIP

Copyright © by American Society for Testing and Materials 1988

NOTE

The Society is not responsible, as a body, for the statements and opinions advanced in this publication.

Peer Review Policy

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM.
Foreword

The symposium on Effect of Steel Manufacturing Processes on the Quality of Bearing Steels was presented at Phoenix, Arizona, 4–6 November 1986. The symposium was sponsored by Committee A01 on Steel, Stainless Steel, and Related Alloys and Subcommittee A01.28 on Bearing Steels. J. J. C. Hoo, General Bearing Corporation, served as chairman of the symposium and editor of this publication.
Contents

Overview

QUALITY REQUIREMENTS FOR BETTER BEARING STEELS

Selection of Rolling-Element Bearing Steels for Long-Life Applications—ERWIN V. ZARETSKY 5

Impact of Steel Quality on Integrated Automotive Wheel Bearing Performance—GHASSAN S. TAYEH AND HELMUT R. WOEHRLE 44

Quantitative Inclusion Ratings and Continuous Casting: User Experience and Relationships with Rolling Contact Fatigue Life—J. MALCOLM HAMPShIRE AND ERNEST KING 61

Effects of Material Properties on Bearing Steel Fatigue Strength—HANS SCHLICHT, ECKE哈RD SCHREIBER, AND OSKAR ZWIRLEIN 81

Failsafe Rating of Ball Bearing Components—AAT P. VOSKAMP AND GRAHAM E. HOLLOX 102

The Role of Carbides in Performance of High-Alloy Bearing Steels—PHILIP K. PEARSON AND THORN W. DICKINSON 113

Rolling Contact Fatigue Life of Various Kinds of High-Hardness Steels and Influence of Material Factors on Rolling Contact Fatigue Life—N. TSUSHIMA, K. MAEDA, AND H. NAKASHIMA 132

Relationship of Melting Practice, Inclusion Type, and Size with Fatigue Resistance of Bearing Steels—JACQUES MONNOT, BERNARD HERITIER, AND JEAN Y. COGNE 149

Discussion

The Distribution and Quantitative Relationship of Oxygen and Inclusions in High-Carbon Ball Bearing Steel—B. BOMARDELLI, G. PACCHIANI, H. HOLZNER, AND JOSEPH J. C. HOO 166

NEW METHODS TO EVALUATE QUALITY OF BETTER BEARING STEELS


Analysis of Microinclusions in Through-Hardening Bearing Steels—STEVEN LANE 211

Measurement of Extremely Low Inclusion Contents by Image Analysis—GEORGE F. VANDER VOORT 226

Inclusion Assessment in Steel Using the New Jernkontoret Inclusion Chart II for Quantitative Measurements—STIG JOHANSSON 250

NEW PROCESSES TO PRODUCE BETTER BEARING STEELS

The Ladle Refining Process for Bearing-Quality Steels— JEFFREY A. ODAR AND DAVID J. FECICHH 263

Quality of High-Carbon Chromium Bearing Steel Produced in the Electric Arc Furnace—Ladle Furnace—RH Vacuum Degassing Vessel—Vertical Continuous Caster— TOSHIKAZU UESUGI AND KAZUICHI TSUBOTA 278

New Developments in the Production and Testing of Bearing Steels—PAUL GERHARD DRESSEL, KARL-JOSEF KREMER, HORST SPITZER, HANS VÖGE, AND LUDWIG WEBER 293

Oxygen Content, Oxidic Microinclusions, and Fatigue Properties of Rolling Bearing Steels—THORE LUND AND JAN ÅKESSON 308

The Effects of Ladle Refining, With and Without Vacuum, on Bearing Steel Quality—D. A. WHITTAKER 331

Fatigue Life of High-Carbon Chromium Ball Bearing Steel Produced by Electric Furnace Vacuum Slag Cleaner—Ladle Furnace—RH Degassing—Curved Continuous Caster— KEN'ICHI KUMAGAI, YATUKA TAKATA, TADAMASA YAMADA, AND KOHICHI MORI 348

Properties of Through-Hardening Bearing Steels Produced by BOF Blowing Metallurgy and by Electric Arc Furnace with Ladle Metallurgy—RUDOLF BAUM, KURT BÖHNKE, TILMAN BOECKERS, AND HARALD KLEMP 360

Ladle Refining: An Integral Part of Bearing Steel Manufacture— I. GWEN DAVIES, MICHAEL A. CLARKE, AND DAVID DULIEU 375

Author Index 391

Subject Index 393