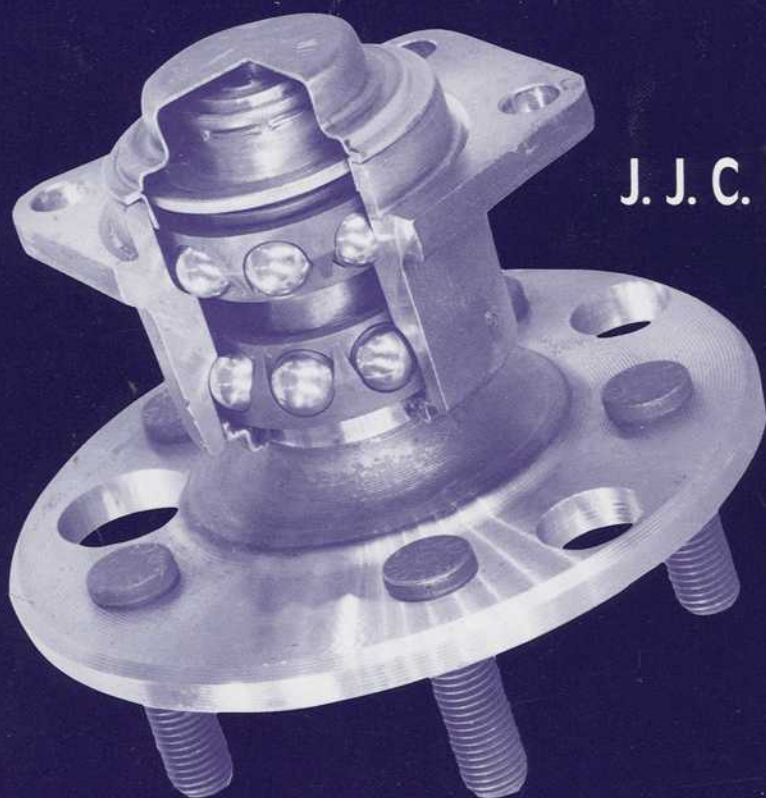


Effect of Steel Manufacturing Processes on the Quality of Bearing Steels

J. J. C. Hoo
editor



ASTM STP 987

STP 987

***Effect of Steel Manufacturing
Processes on the Quality of
Bearing Steels***

J. J. C. Hoo, editor



ASTM
1916 Race Street
Philadelphia, PA 19103

Library of Congress Cataloging-in-Publication Data

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

I. Steel, Bearing—Fatigue—Congresses. 2. Rolling contact—Congresses. 3. Steel—Metallurgy—Congresses. I. Hoo, J. J. C. II. Symposium on Effect of Steel Manufacturing Processes on the Quality of Bearing Steels (1986: Phoenix, Ariz.) III. American Society for Testing and Materials. Subcommittee A01.28 on Bearing Steels. IV. Series: ASTM special technical publication; 987.

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	1
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, ECKEHARD 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	
The Development of an ASTM Standard Analytical Method for the Determination of Oxygen in Steel—BARRY I. DIAMONDSTONE AND DEAN A. FLINCHBAUGH	191
Current Status of Round-Robin Testing of Oxygen Content in Bearing Steels—W. B. GREEN, JR., B. I. DIAMONDSTONE, AND JOSEPH J. C. HOO	198

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. FECICH	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

ISBN 0-8031-0999-7