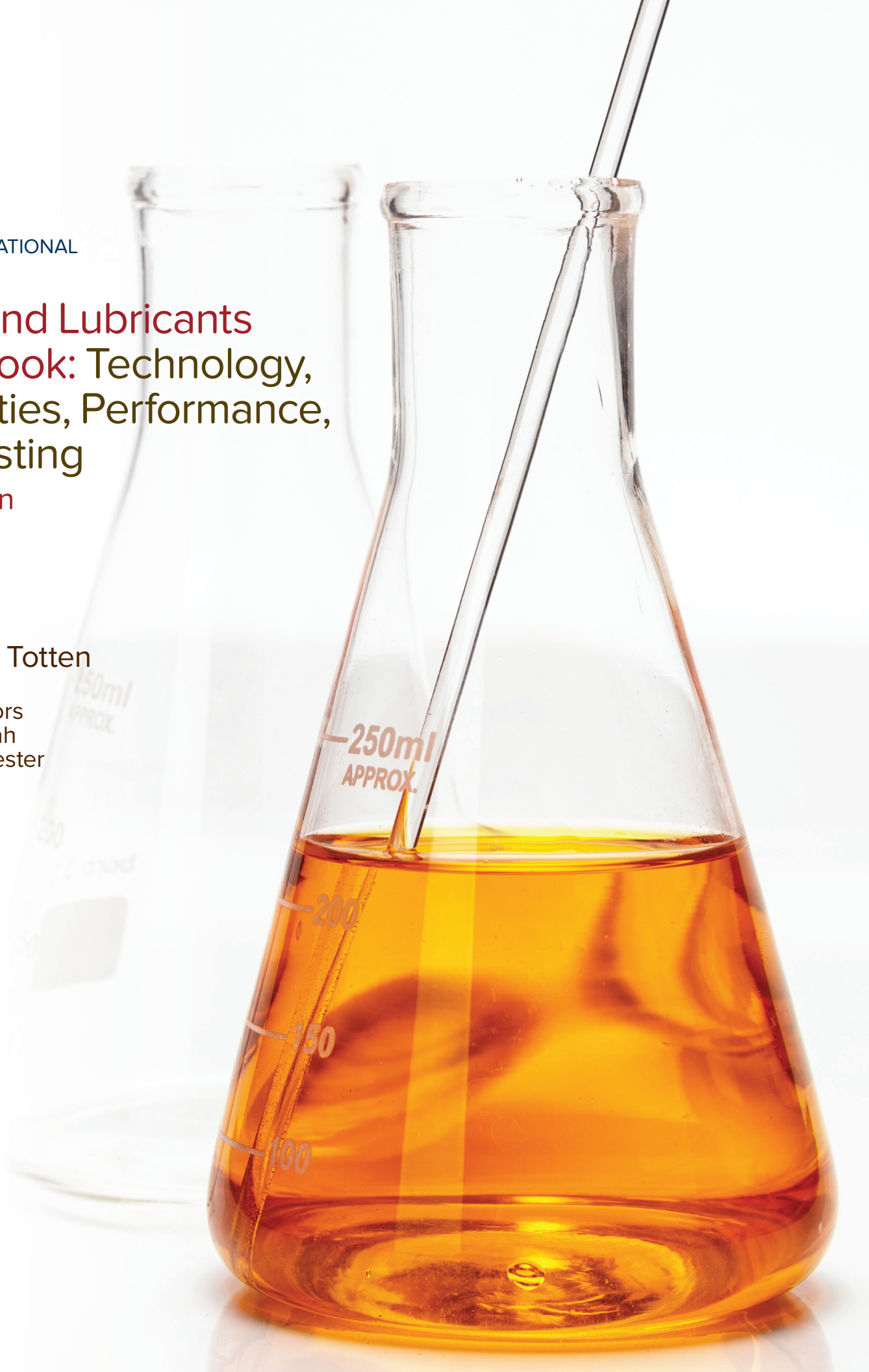
ASTM INTERNATIONAL
Manual

Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing

2nd Edition

Editor
George E. Totten

Section Editors
Rajesh J. Shah
David R. Forester



George E. Totten, Editor

Rajesh J. Shah and David R. Forester, Section Editors

Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing

2nd Edition

ASTM Stock Number: MNL37-2ND

ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in U.S.A.

Library of Congress Cataloging-in-Publication Data

Names: Totten, George E., editor. | Shah, Rajesh J., editor. | Forester, David R., editor.
Title: Fuels and lubricants handbook : technology, properties, performance, and testing / [edited by] George E. Totten, Rajesh J. Shah, David R. Forester.
Description: 2nd edition. | West Conshohocken, PA : ASTM International, [2019]
Identifiers: LCCN 2019011813 | ISBN 9780803170896
Subjects: LCSH: Fuel—Testing—Methodology. | Fuel—Analysis. | Lubrication and lubricants—Analysis.
Classification: LCC TP321 .F84 2019 | DDC 662/.6—dc23
LC record available at https://lccn.loc.gov/2019011813

Publisher:
ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959
Phone: (610) 832-9585 Fax: (610) 832-9555

ISBN 978-0-8031-7089-6
ISBN-EB: 978-0-8031-7090-2

ASTM Stock Number: MNL37-2ND
DOI: 10.1520/MNL37-2ND-EB

Printed in Minneapolis, MN
September 2019

Foreword

THIS PUBLICATION, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, 2nd Edition*, was sponsored by ASTM Committee D02 on Petroleum Fuels and Lubricants and edited by George E. Totten (G. E. Totten & Associates, LLC, Seattle, WA). The section editors were Rajesh J. Shah (Koehler Instrument Company, Holtsville, NY) and David R. Forester (Fuel Quality Services, Inc., Flowery Branch, GA). This publication is Manual 37: 2ND of ASTM's manual series.

Dedication

I am especially indebted to the continuing support of my wife, Alice Totten (George)

To Kian, who always inspires and taught me patience and gratitude (Raj)

To Lisa Drennen, for her countless hours of assistance with ASTM technical committee ballots, minutes, and standard documents, and for her unwavering support (David)

The editors also express their sincere appreciation to all the contributing authors and staff for the dedication and patience in providing their vital assistance in making this extensive work become a reality.

Contents

Preface

The original objective of ASTM's *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing* was to provide an extensive, in-depth, well-referenced manual on fuels and lubricants. Although the primary focus of this handbook is on petroleum fluids, there is also coverage of nonpetroleum materials such as synthetic lubricants, vegetable oils, and ionic fluids when they may be used as functional alternatives to their petroleum counterparts.

The ASTM *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, First Edition* was published in 2003 and it contained 38 chapters. Although still widely used throughout the world as an internationally recognized standard reference text, after 15 years it was vital that it be updated. This was the primary goal of the current edition of the book. The chapters contained in *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, Second Edition* have been updated and, in most cases, rewritten. Furthermore, the addition of new chapters represents a significant increase in the breadth and depth of coverage, reflecting the continuing vital importance of petroleum technology. Topics covered in the 49 chapters contained in this book include an overview of general material production, fuels, lubricants, greases, nonpetroleum process fluids, ionic fluids, and testing.

With the revised and updated material, in addition to substantially expanded coverage, we expect that the ASTM *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, Second Edition* will continue its tradition as a prominent international academic and industrial reference.

George E. Totten received his BS and MS degrees from Fairleigh Dickinson University in New Jersey and his Ph.D. from New York University. Dr. Totten is past-president of the International Federation for Heat Treating and Surface Engineering (IFHTSE) and a fellow of ASM International, SAE International, ASTM International, IFHTSE and he is a Founding Fellow of AMME (World Academy of Materials Manufacturing Engineering). Dr. Totten is a Professor at Portland State University, Portland, OR and a visiting professor at the University of Sao Paulo in Sao Carlos, Brazil. He is also president of G.E. Totten & Associates LLC, a research and consulting firm specializing in Thermal Processing and Industrial Lubrication problems. Dr. Totten is the author or coauthor (editor) of approximately 800 publications including patents, technical papers, chapters and books.

David R. Forester serves Fuel Quality Services, Inc. as Global Products Development Manager. He has over 40 years' experience in the fuel and refining additive business and has over 35 US patents on development of diesel and jet fuel additives, refinery antifoulants, and other refinery and process related additives. He has designed, implemented and/or automated many fuel test methods, including many ASTM standards that have resulted in new additive products, reformulations, and improvements to diesel fuel additive products.

Mr. Forester is a member of ASTM International Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and currently serves as Chairman of Subcommittee D02.14 Stability, Cleanliness and Compatibility of Liquid Fuels. He has received numerous awards including the Lowrie B. Sargent Leadership Award, the Sydney D. Andrews Scroll of Achievement, and the Eagle Award. He is also a member of the Society of Automotive Engineers (SAE) and TC-7, and led a major rewrite effort of J313 Surface Fuel Standard on diesel fuel.

Mr. Forester has authored or coauthored multiple SAE and International Association for Stability, Handling and Use of Liquid Fuels (IASH) papers/presentations, and coauthored Chapter 11 "Methods for Assessing Stability and Cleanliness of Liquid Fuels" in Significance of Tests for Petroleum Products, 8th Edition, published 2010 by ASTM.

Mr. Forester graduated in 1975 with a BA in Chemistry from Texas A & M University.

Raj Shah is a Director at Koehler Instrument Company, in Long Island, NY where he has been working for the past two decades. He holds a Bachelor's degree in Chemical Engineering from the Institute of Chemical Technology (ICT), a Ph.D. in Chemical Engineering from The Pennsylvania State University and a MCP degree in Marketing and Management from Long Island University. Dr. Shah also has the distinction of being the only person to hold all 6 of these highly coveted certifications: CPC, CChE, CEng, CSci, CChem, and CPEng., and the singular honor of being an elected Fellow of these international professional organizations: namely, STLE, NLGI, AIC, RSC and EI.

Raj is a Certified Professional Chemist and a Certified Chemical Engineer with the National Certification Commission in Chemistry and Chemical Engineering. He has also been awarded the Chartered Scientist status from the Science Council, UK, the Chartered Chemist status from the Royal Society of Chemistry, and the Chartered Engineer status from the Engineering council, UK.

Dr. Shah had been recently conferred the distinction of being a Chartered Petroleum Engineer from the Energy Institute in recognition of his specific expertise as a practitioner in energy engineering. Dr. Shah is also a recipient of the PM Ku medal from STLE and the Bellanti Memorial award from NLGI.

Dr. Shah is an active member of ASTM, STLE, NLGI, SAE, ACS, AOCS, SPE, IFT and AICHE and chairs various subcommittees in several of these organizations .He has been a co-instructor for the ASTM Motor Gasoline course, and the ASTM Fuel Technology course. Raj is also a three-time recipient of the ASTM Award of Excellence and the ASTM Eagle Award from Committee D02.

Dr. Shah is an elected fellow of the Royal Society of Chemistry, which is typically awarded by one's peers to signify a scientist's high level of accomplishment. He was awarded his fellowship from the STLE, in recognition of his outstanding contributions to the field of lubrication and tribology and he received his Fellow award at NLGI International for his work on greases.

He has over 100 publications and was also a coeditor of the first edition of this book. He has received multiple awards from NLGI India and is also a distinguished alumni award recipient from the Institute of Chemical Technology.

Raj has volunteered on the Founders board of directors of Developmental Disabilities institute, a school for autistic children on Long Island, and served on the NLGI board of directors for over 15 years. He is currently on the advisory boards of The Department of Chemical Engineering, State University of New York, Stony Brook; The School of Engineering, Design, Technology and Professional programs (SEDTAPP), Pennsylvania State University; and the Samuel Ginn College of Engineering, Tribology and Lubrication Science Minor at Auburn University. Fluent in multiple languages, he enjoys kayaking, mixology, mobile photography and lives in Melville, NY with his family.

ASTM INTERNATIONAL
Helping our world work better

ISBN: 978-0-8031-7089-6
Stock #: MNL37-2ND

www.astm.org