



Spectroscopic Analysis

of Petroleum Products and Lubricants

R.A. Kishore Nadkarni



Spectroscopic Analysis of Petroleum Products and Lubricants

R. A. Kishore Nadkarni

ASTM Stock Number: MON09



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

Spectroscopic analysis of petroleum products and lubricants / R.A. Kishore Nadkarni.

p. cm.

"ASTM stock number: Mono 9."

Includes bibliographical references.

ISBN 978-0-8031-7020-9

1. Petroleum products—Analysis. 2. Lubricating oils—Analysis. 3. Spectrum analysis. 4. Petroleum—Spectra. I. Nadkarni, R. A.

TP691.S686 2011

665.5'38—dc23

2011012484

Copyright © 2011 ASTM International, West Conshohocken, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use of specific clients is granted by ASTM International provided that the appropriate fee is paid to ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9634; online: <http://www.astm.org/copyright/>

ASTM International is not responsible, as a body, for the statements and opinions advanced in the publication. ASTM does not endorse any products represented in this publication.

Printed in Bridgeport, NJ
August, 2011

Foreword

THIS PUBLICATION, *Spectroscopic Analysis of Petroleum Products and Lubricants*, was sponsored by Committee D02 on Petroleum Products and Lubricants. The Editor is R. A. Kishore Nadkarni, Millennium Analytics, Inc., East Brunswick, NJ. This is Monograph 9 in ASTM's monograph series.

Contents

Part 1: Analytical Basics

Chapter 1—Overview of Spectroscopic Analysis of Petroleum Products and Lubricants	3
<i>by R. A. Kishore Nadkarni</i>	

Chapter 2—Calibration Protocols for Spectroscopic Measurements of Petroleum Products	24
<i>by R. A. Kishore Nadkarni</i>	

Chapter 3—Quality Assurance in Spectroscopic Analysis of Petroleum Products and Lubricants	42
<i>by R. A. Kishore Nadkarni</i>	

Chapter 4—Analyzing and Interpreting Proficiency Test Program Data for Spectroscopic Analysis of Petroleum Products and Lubricants.	74
<i>by W. James Bover</i>	

Chapter 5—Calibration and Quality Control Standards and Reference Materials for Spectroscopic Analysis of Petrochemical Products.	112
<i>by R. A. Kishore Nadkarni</i>	

Part 2: Analytical Technology

Chapter 6—Atomic Absorption Spectrometry in the Analysis of Petroleum Products and Lubricants	135
<i>by R. A. Kishore Nadkarni</i>	

Chapter 7—Graphite Furnace Atomic Absorption Spectrometry for the Analysis of Petroleum Products and Lubricants	156
<i>by Paolo Tittarelli</i>	

Chapter 8—Inductively Coupled Plasma Atomic Emission Spectrometry in the Petroleum Industry with Emphasis on Organic Solution Analysis.	170
<i>by Robert I. Botto</i>	

Chapter 9—Applications of ICP-MS in the Petroleum Industry	208
<i>by J. David Hwang</i>	

Chapter 10—Atomic Fluorescence Spectrometry: An Ideal Facilitator for Determining Mercury and Arsenic in the Petrochemical Industry	246
<i>by Peter B. Stockwell</i>	

Chapter 11—Applications of Mass Spectrometry in the Petroleum and Petrochemical Industries	287
<i>by Aaron Mendez and Todd B. Colin</i>	

Chapter 12—Wavelength Dispersive X-ray Spectrometry	349
<i>by Bruno A. R. Vrebos and Timothy L. Glose</i>	

Chapter 13—Energy Dispersive X-ray Fluorescence and Its Applications in the Field of Petroleum Products and Lubricants	374
<i>by C. A. Petiot and M. C. Pohl</i>	

Chapter 14—Low-Power Monochromatic Wavelength-Dispersive X-ray Fluorescence—Principle and Applications in Petroleum Products	392
<i>by Z. W. Chen and Fuzhong Wei</i>	
Chapter 15—Neutron Activation and Gamma Ray Spectrometry Applied to the Analysis of Petroleum Products	410
<i>by R. A. Kishore Nadkarni</i>	
Chapter 16—A Review of Applications of NMR Spectroscopy in the Petroleum Industry.	423
<i>by John C. Edwards</i>	
Chapter 17—Infrared Spectroscopic Analysis of Petroleum, Petroleum Products, and Lubricants	473
<i>by James M. Brown</i>	
Chapter 18—Ion Chromatography in the Analysis of Industrial Process Waters and Petroleum Products.	494
<i>by Kirk Chassaniol</i>	
Chapter 19—Chromatography Applied to the Analyses of Petroleum Feedstocks and Products: A Brief Overview	511
<i>by Frank P. Di Sanzo</i>	
Part 3: Analytical Applications	
Chapter 20—Spectroscopic Methods for the Determination of Sulfur in Petroleum Products	541
<i>by R. A. Kishore Nadkarni</i>	
Chapter 21—Atomic Spectroscopic Determination of Mercury in Fossil Fuels	565
<i>by R. A. Kishore Nadkarni</i>	
Chapter 22—Spectroscopic Analysis of Used Oils	582
<i>by R. A. Kishore Nadkarni</i>	
Chapter 23—Elemental Analysis of Crude Oils Using Spectroscopic Methods.	605
<i>by R. A. Kishore Nadkarni</i>	
Chapter 24—Spectroscopic Analysis of Biofuels and Biolubes.	625
<i>by R. A. Kishore Nadkarni</i>	
Index	639

About the Author

DR. R. A. KISHORE NADKARNI received his Ph.D. in analytical Chemistry at the University of Bombay. Since then he has worked as a Research Associate at the University of Kentucky, Manager of the Materials Science Center Analytical Facility at Cornell University, and analytical Leader in the ExxonMobil Company. In his last position he was responsible for technical quality management of the Paramis Division's global plant laboratories.



He has authored over 100 technical publications in the area of analytical chemistry and quality management. He is a member of the American Chemical Society, ASTM, and the American Society for Quality. He is very active in ASTM and ISO in the petroleum products and lubricant field, holding the position of immediate Past Chairman of ISO/TC28, Chairman of ASTM's D02.SC3 on Elemental Analysis, Vice-Chairman of D02.CS 92 on Interlaboratory Cross-Check Programs, D02.CS 94 on Quality and Statistics, and Editor of the D02.CS.92 Newsletter.

He has received the Award for Appreciation (1991) and Awards for Excellence (1998 and 1999) from ASTM's D02 Committee for his contribution to the oil industry, the Award of Merit (2005), and the George Dyroff Award of Honorary D02 membership (2006).

www.astm.org

ISBN 978-0-8031-7020-9
Stock #: MONO9