Suffue Analysis of Fossil Fuel Products

R.A. Kishore Nadkarni



Standards Worldwide



R. A. Kishore Nadkarni

Sulfur: Chemistry and Analysis of Fossil Fuel Products

ASTM Stock Number: MONO11

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

Library of Congress Cataloging-in-Publication Data

Nadkarni, R. A.

Sulfur : chemistry and analysis of fossil fuel products / R.A. Kishore Nadkarni. pages cm. - (ASTM International's monograph series ; 11)
"ASTM Stock Number: MONO 11."
Includes bibliographical references and index.
ISBN 978-0-8031-7052-0
Petroleum–Sulfur content. 2. Petroleum products–Analysis. I. Title.
TP692.4.S9N33 2014
665.5'38-dc23

2013036927

Copyright © 2014 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.

ASTM 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 International does not endorse any products represented in this publication.

Printed in Bridgeport, NJ Date: July 2014

Foreword

THIS PUBLICATION, Sulfur: Chemistry and Analysis of Fossil Fuel Products, was sponsored by Committee D02 on Petroleum Products and Lubricants. This is Monograph 11 in ASTM International's monograph series.

Acknowledgments

I have to thank my former employers who provided facilities and allowed me to pursue my research interests in analytical chemistry: Exxon Research and Engineering Company; Exxon Chemical Company—Paramins Manufacturing Technology Division; ExxonMobil Research and Engineering Company; and Infineum USA, LLC.

I am indebted to the following colleagues in the above companies: Kevin Bly, Alex Lau, Dr. Richard Ledesma, and Dr. Kelly Mason. I also thank the following colleagues from the oil industry involved in ASTM work: John Crnko of ASI, Dr. Keith Dahnke of ConocoPhillips, Dr. Mike Pohl of Horiba Instruments, and Bill Tanguay of Metrotech Systems. All of them were key players in our efforts to develop the best regulatory test methods for sulfur in petroleum products. All of them helped me in this work and know far more about the subject than I do.

Special thanks are due to various ASTM staff members, principal among them Kathy Dernoga, Managing Editor, and Monica Siperko, Publishing Specialist. Also, Rebecca Edwards (senior project manager) at Cenveo Publisher Services for her work during the publication process.

I am, of course, eternally grateful to my beloved wife, Nancy Joanne, for her unfailing support while I was busy with writing, teaching, and traveling around the world.

Contents

	Foreword	iii
	Acknowledgments	iv
1.	Introduction	1
2.	Analytical Techniques for Sulfur Determination	9
3.	Analysis of Coal and Coke Products	35
4.	Analysis of Oil Shales	53
5.	Analysis of Petroleum Products	59
6.	Analysis of Lubricants and Additives	153
7.	Analysis of Gaseous Fuels	163
8.	Analysis of Biofuels	195
9.	Proficiency Testing Programs for Sulfur in Petroleum Products and Lubricants	207
	Appendix 1 ASTM Standards Cited	243
	Appendix 2 Index of Description of ASTM Test Methods	245
	Index	249



Dr. R.A. Kishore Nackarni 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 Paramins Division's global plant laboratories.

He has authored more than 140 technical publications including 21 new ASTM standards in the area of

analytical chemistry and quality management. He is a member of the American Chemical Society and ASTM International. 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 D02.03 on Elemental Analysis, vicechairman of D02.92 on Proficiency Test Programs, D02.94 on Quality Assurance and Statistics.

Dr. Nadkarni has received the Award of Appreciation (1991) and Awards for Excellence (1998, 1999, and 2013) 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), and the Sydney Andrews D02 Scroll of Achievement Award (2005).

He is the author or editor of STP 1109, *Modern Instrumental Methods of Elemental Analysis of Petroleum Products and Lubricants* (1991); STP 1468, *Elemental Analysis of Fuels and Lubricants* (2005); Manual 44, *Guide to ASTM Test Methods for the Analysis of Petroleum Products and Lubricants* (2007); Manual 61, *Guide to ASTM Test Methods for the Analysis of the Analysis of Coal and Coke* (2008); Monograph 9, *Spectroscopic Analysis of Petroleum Products and Lubricants* (2011); and Monograph 10, *"Elemental Analysis of Fossil Fuels and Related Materials"* (2014).

www.astm.org ISBN: 978-0-8031-7052-0 Stock #: M0N011