Environmental Toxicology and Risk Assessment

Second Volume

Gorsuch/Dwyer/
Ingersoll/LaPoint
editors

ASTM
STP 1216

STP 1216

Environmental Toxicology and Risk Assessment: 2nd Volume

Joseph W. Gorsuch, F. James Dwyer, Christopher G. Ingersoll, and Thomas W. La Point, editors

ASTM Publication Code Number (PCN)
04-012160-16

ASTM
1916 Race Street
Philadelphia, PA 19103
Printed in the U.S.A.

ISSN: 1071-720X
ASTM Publication Code Number (PCN): 04-012160-16
ISBN: 0-8031-1485-0

Photocopy Rights

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.

To make technical information available as quickly as possible, the peer-reviewed papers in this publication were printed "camera-ready" as submitted by the authors.

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 to time and effort on behalf of ASTM.

Printed in Philadelphia, PA
October 1993

Foreword

This publication, *Environmental Toxicology and Risk Assessment: 2nd Volume*, contains papers presented at the symposium on Environmental Toxicology and Risk Assessment: Aquatic, Plant, and Terrestrial, held in Pittsburgh, PA on 26–30 April, 1992. The symposium was sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate. Joseph W. Gorsuch of Eastman Kodak in Rochester, NY; F. James Dwyer and Christopher G. Ingersoll of the U.S. Fish and Wildlife Service in Columbia, MO; and Thomas W. La Point of Clemson University in Pendleton, SC presided as symposium chairmen and are editors of the resulting publication.

Contents

Plants for Toxicity Assessments

Risk Assessment

SAR/QSAR in the Office of Pollution Prevention and Toxics

Overview

The Second Symposium on Environmental Toxicology and Risk Assessment: Aquatic, Plant, and Terrestrial, held in Pittsburgh, PA, during 26–29 April 1992 continues in what has been a series of 18 successful ASTM Environmental Symposia. The meeting was well attended with 203 participants, including individuals from Canada, Sweden, India, Venezuela, the Netherlands, and the United States. The format for the Second Symposium was sightly different from the first in that it integrated Subcommittee development of standards with symposium presentations. This new format provided greater opportunity for participation by individuals attending the meeting in the development of standards, which is why ASTM is still such a necessary and respected Society.

The Symposium began with a plenary session titled "Greening of the International Marketplace" presented by James Fava (Weston Company) and Frank Consoli (Scott Paper Products). Environmentally friendly manufacture, use, and disposal of products is such an important topic that the presenters were asked, and graciously provided, a brief summary of Product Life-Cycle Assessment, which follows the Overview.

During the following three days, ten platform sessions and a poster session covered a wide array of topics. Some covered more traditional topics including: aquatic toxicology, biomarkers, ecosystems, effluent toxicology, plant toxicology, and sediment toxicology. It is somewhat surprising to realize that topics such as effluent and sediment toxicology are now considered "traditional," especially since we can remember when these efforts were just getting started. Many of the papers and related posters presented in these sessions are included in this volume.

As was the case in the first symposium, presentations on Ecological Risk Assessment were well-attended. Two sessions were devoted to Ecological Risk Assessment. The first session on Ecological Risk Assessment focused on the multiple uses of quantitative structure activity relationships (QSARs) by the U.S. EPA Office of Pollution Prevention and Toxics (OPPT). All the papers presented within this session have been published in a separate section within this Special Technical Publication (STP). Hopefully, this provides readers with pertinent information regarding OPPT's use of QSARs. The second session covered such topics as: issues of scale and uncertainty, defining scientific procedural standards, and the presentation of ecological risk assessments for specific contaminants and ecosystems.

There were several "firsts" for ASTM at this meeting. Subcommittee E47.12 on Behavioral Toxicology met for the first time. To launch this Subcommittee's activities, a session dedicated to topics associated with Behavioral Toxicology was held. Papers focused on the status of fish behavioral toxicology and included: avoidance-attractance, behavioral activity, respiratory monitoring, and predator-prey interactions, while other papers focused on behavioral toxicology of invertebrates and birds.

This Symposium presented the first session for ASTM dedicated to environmental neurotoxicology. The Neurotoxicology session was also well represented with five of the papers presented at the session published in this STP.

This STP contains 45 papers covering the areas of environmental toxicology and risk assessment. There are eight groupings of papers within the STP; however, as is always the case, several papers span multiple topics. The papers in this STP present the development of new research techniques, synopses of available techniques, findings concerning various

environmental stressors, and the application of techniques and processes to environmental assessment.

We would like to thank the session chairs who recruited speakers and organized sessions: Plant Toxicology, Jerry Barker (Mantech Environmental Technology, Inc., Corvallis, OR) and Jim Hoberg (Springborn Laboratories, Inc., Wareham, MA); Sediment Toxicology, Marcia Nelson (U.S. Fish and Wildlife Service, Columbia, MO) and Beth McGee (U.S. Environmental Protection Agency, Washington, DC); SAR/QSAR in the Office of Pollution Prevention and Toxics, Maurice Zeeman (U.S. Environmental Protection Agency, Washington, DC); Biomarkers, Greg Linder (Mantech Environmental Technology, Inc., Corvallis, OR); Effluent Toxicity, Tom Abrahamsen (Eastman Chemical Co., Kingsport, TN) and Remi van Compernolle (Shell Development Co., Houston, TX); Environmental Neurotoxicology, Behrus Jahan-Parwar (State University of New York, Albany, NY); Aquatic Toxicity, Laverne Cleveland (U.S. Fish and Wildlife Service, Columbia, MO); Ecological Risk Assessment, Greg Biddinger (Exxon Biomedical Sciences, East Millstone, NJ); Behavioral Toxicology, Ed Little (U.S. Fish and Wildlife Service, Columbia, MO); Poster Session, Mark Hinman (Exxon Biomedical Sciences, East Millstone, NJ) and John Walker (U.S. Environmental Protection Agency, Washington, DC). Also, we would like to thank the ASTM staff that helped us with planning the Symposium and this STP: Dorothy Savini (Symposium Planning); Kathy Dernoga, Therese Pravitz, and Lynn Hanson (Acquisitions and Review); Ken St. John (Representative of Committee on Publications (COP)), University of Mississippi, MS); and Susan Canning (Committee E 47 Staff Manager).

As we wrap up this second volume on Environmental Toxicology and Risk Assessment, the third symposium will have been held, new techniques and modification of old techniques will have been presented for environmental assessments, and Subcommittees will have been working towards consensus on standard methods. There are many other societies and organizations to which many of us belong. And while some of these groups may have highly visible roles in various aspects of the environmental sciences, ASTM provides a forum for consensus and standardization of methods necessary to evaluate and protect our fragile environment.

Joseph W. Gorsuch

Eastman Kodak Company, Rochester, NY; symposium chirman and editor.

F. James Dwyer

U.S. Fish and Wildlife Service, Columbia, MO; symposium chairman and editor.

Christopher G. Ingersoll

U.S. Fish and Wildlife Service, Columbia, MO; symposium chairman and editor.

Thomas W. La Point

Clemson University, Pendleton, SC; symposium chairman and editor.

Synopsis of Plenary Session

Product Life-Cycle Assessment

The purpose of this material is to describe Life-Cycle Assessment (LCA) and to briefly discuss possible applications.

Product life-cycle assessment is a process used to evaluate the environmental burdens associated with a product, process, or activity. This data is then used to assess the impact of those energy and material uses and releases on the environment, and to evaluate and implement opportunities to achieve environmental improvements. LCA includes the entire life-cycle of the product, process or activity, encompassing, extracting, and processing of raw materials; manufacturing, transportation, and distribution; use, re-use, maintenance; recycling; and final disposal. In 1991, the Society of Environmental Toxicology and Chemistry developed a technical framework for LCA. That report provides a discussion on the state-of-the-practice of product LCA.

A complete LCA consists of separate but interrelated components: inventory, impact, and improvement analysis. It should be emphasized that most of the past efforts to develop or conduct life-cycle assessment have focused on the inventory component. These three components comprise an integrated approach that, when combined with other appropriate data, can provide the insight needed to achieve and maximize environmental improvements.

Environmental benefits can be realized at each step in the LCA process. For example, the inventory alone may be used to identify opportunities for reducing emissions, energy, and material use. The impact analysis and improvement analysis tools, however, help ensure that these potential reduction strategies are optimized and that improvement programs do not produce unanticipated impacts.

The LCA is a dynamic and iterative process of evaluation. For example, changes in the material input to a manufacturing process or changes in the process itself may trigger the need for an updated inventory. Likewise, new information pertaining to human or environmental exposure and toxicity may trigger the need to update the impact and improvement analyses.

Life-Cycle Inventory

The foundation, and most practiced component of an LCA is the inventory. It is in this component that a quantification of energy, raw materials, and environmental releases occur throughout the life cycle of the product. The major life-cycle inventory stages focus on (1) raw materials acquisition, (2) manufacturing, processing, and formulation; (3) distribution and transportation, (4) use/re-use/maintenance, (5) recycling, and (6) waste management. In general, each stage receives inputs of materials and energy and produces outputs of materials or energy that move to subsequent stages and wastes that are released into the environment.

An example illustrates how companies can use the application of product LCAs today to understand and make decisions concerning environmental and resource issues associated with their products, processes, or packaging. Scott Paper Company has decided to apply the concept of product LCA internally to gain insights in its operations. Scott has developed a strategy to consider resource and environmental issues along the entire life cycle of products

starting from natural resources, raw material, manufacture, product and packaging development, and product use and disposal. The ultimate endpoint for Scott's LCA work will be to incorporate life-cycle consideration into its product/process development system.

In conclusion, companies who have integrated life-cycle environmental, health, safety, and resource considerations with their product design and development systems and total quality management practices will become preeminent among their peers. A proactive program provides a management tool to effectively and efficiently implement actions, on a product-by-product basis, to continually improve the environmental quality of products, packaging, processes, and activities. Overall, this results in the long-term sustained success of a company.

James A. Fava

Roy F. Weston, Inc.,
West Chester, PA.

Frank J. Consoli

Scott Paper Company,
Philadelphia, PA.

ISBN 0-8031-1485-0