Volatile Organic Compounds (VOC) Reactivity

RRWG Initial Assessment Report

Executive Summary

Prepared by:

REACTIVITY
RESEARCH
WORKING
GROUP

Disclaimer

The participants in the RRWG have developed several documents to highlight the scientific issues and to identify future research needs concerning VOC emissions. It should be noted, however, that this executive summary and the documents referred therein do not necessarily represent the opinion of each participant of the RRWG, the organizations with which these individuals are affiliated, or the RRWG as a whole. The RRWG does not intend this executive summary to constitute consensus advice or recommendations to EPA or any other regulatory body regarding future regulation of VOC.

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Reactivity Research Working Group - Research Program

GOAL:	Identify and promote research projects to improve the scientific basis for VOC reactivity-related regulatory policies.
WHY:	VOC regulations that take into account differences in VOC reactivity have the potential of being more effective in improving air quality.
WHAT:	VOC reactivity represents the impact of an individual hydrocarbon in the atmospheric chemical formation of ozone and other measures of air quality.
HOW:	The Reactivity Research Working Group (RRWG) comprised of industrial, governmental, and research organizations have prepared a research plan based on an initial science and policy assessment report focusing on VOC reactivity and air quality. The RRWG promotes the generation, funding and use of VOC reactivity policy-relevant science among all interested parties.
PLAN:	The VOC reactivity research plan is comprised of research projects intended to inform the critical questions on measures of reactivity, levels of uncertainty, and potential applicability. The work plan is prioritized by near term and longer-term initiatives.
OUTCOME:	With improved scientific information on VOC reactivity, policy development will be better informed and more effective.

Reactivity Research Working Group
Mission Statement

"Our mission is to provide an improved scientific basis for reactivity-related regulatory policies. That will be accomplished by bringing together all parties actively interested in sponsoring, planning, performing or assessing policy-relevant scientific research on the reactivities of organic compounds emitted to ambient air, as related to the formation of ozone, PM2.5, and regional haze. This is for the purposes of coordinating such research and defining potential applications, while continuously involving key policymakers."

SUMMARY

VOC Reactivity

The role of hydrocarbons (VOC) and oxides of nitrogen (NOx) in the atmosphere as precursors to the formation of ozone (O3) and other secondary products is well established. The variety of hydrocarbon compounds released to the atmosphere is quite large. Atmospheric "reactivity" refers to the impact of an individual VOC on the formation of O3 and other measures of air quality. Methods to determine reactivity must account for the complex non-linear nature of mixtures of hydrocarbons in the atmosphere. Differences in the comparative contributions or "reactivity" of individual VOCs to ozone formation have been documented in laboratory chambers and other controlled conditions.

Current VOC Control Approaches

Measures to improve air quality depend on reducing emissions of VOC and NOx to the atmosphere via various control strategies. Efforts to control VOC emissions to the atmosphere rely extensively on reducing the mass of various hydrocarbon compounds released to the atmosphere, e.g., mobile source reductions expressed as mass/vehicular miles traveled, stationary sources as mass/unit of process, and consumer products as mass/unit of product. Industries have responded to this approach by modifying processes and/or products. The VOC mass reduction approach has contributed to improvements in air quality in selected areas.

RRWG Organization

The concept of VOC reactivity and the prospect of its incorporation explicitly in emission control strategies provide the framework for the formation and activities of the Reactivity Research Working Group (RRWG). The explicit use of VOC reactivity exists in some regulatory settings such as California. Air pollution control strategies have already implicitly introduced VOC reactivity via implementation of specific mass based controls on various emissions categories, e.g., mobile vs. stationary HC sources. The explicit role of VOC reactivity in these air pollution control programs is generally undocumented.

Established in July 1998, the RRWG brings together interested parties for addressing VOC reactivity issues focusing on identifying policy-relevant science. The RRWG is open to all interested parties and is currently comprised of representatives from federal, state and local agencies, industries and trade associations, consulting organizations, academic and research institutions.

VOC Reactivity -Initial Assessment Report

The RRWG has prepared an initial assessment report developed by two teams: the science assessment team led by William P. L. Carter, University of California - Riverside; and the policy assessment team led by Tom Helms - US EPA Office of Air Quality Planning and Standards. Two documents prepared by the teams and this executive summary represent the RRWG Initial Assessment Report on VOC reactivity. The RRWG science assessment document identifies the state of science with respect to VOC reactivity. The document also describes the areas where additional work is needed in order to reduce the uncertainty associated with different approaches to assessing reactivity. The VOC policy assessment document identifies several design issues that are important for consideration of explicit use of VOC reactivity in future policy considerations.

Issues Identified in VOC Assessment Documents.

Science Issues
- Atmospheric Chemistry
- Computational / Modeling Technology
- Smog Chamber Studies
- Aerosol Form. Potential
- Emission Data
- Volatility and Fate
- Air Quality Models
- Environmental Conditions
- Reactivity Assessments
- Persistent Organic Pollutants

Policy Issues
- Multiple Impacts of Concern
- Geographical Scope of Application
- Relationship to Source Type
- Atmospheric Availability of affected VOCs
- Uncertainty in the Reactivity Characterization
- Analytical Methods / Compliance Monitoring

RRWG VOC Research Plan

The VOC science and policy assessment reports provide the basis for a research plan to address the following global question:

> How can modifications of VOC emissions be evaluated on the basis of their chemical role in the formation of ozone, PM2.5 and regional haze?

Answers to this question and associated questions provide the opportunity to consider relative reactivity of VOCs in the development of control strategies for atmospheric ozone, PM2.5 and regional haze.

A comprehensive research plan identifying research questions and associated projects has been prepared by the RRWG. The RRWG has extracted from this plan a set of tasks that represent near term projects focusing on existing data and tools shown in Table 1.

Table 1. Prioritized Near Term Projects

- Assess effects of large-scale reactivity-based substitutions on regional air quality using existing models [1.2.A]
  - Evaluate alternative reactivity metrics [1.5.1]
  - Uncertainty analysis [1.6]
- Analyze available information relevant to how much of the environment would be sensitive to VOC controls, and the distribution of conditions appropriate for reactivity assessments [5.1.1A & B]
- Improve information on atmospheric availability of VOC with low volatility, [4.1], and evaluate existing fugacity models [4.3]
- Survey amounts of emissions that are suitable for reactivity-based controls [3.1.1]
- Develop appropriate scenarios for general reactivity assessment [5.1,3].
- Survey existing modeling assessments [1.1]
- Develop model criteria for reactivity assessments [6.1]
- Improve emissions processing modules in models [6.3.2]
- Use existing models to evaluate exemption standard [1.3.A]
- Evaluate existing chamber data base [2.4.1]

Supporting Documents

VOC Reactivity Science Assessment Document WWW.
VOC Policy White Paper WWW
RRWG VOC Reactivity Research Plan
RRWG Prioritized List of Research Projects
RRWG Mailing / Membership List

RRWG Meetings

The RRWG membership meets 4 times per year to discuss scientific projects, refine the research plan, and identify potential sponsors. The meetings are most often located in Research Triangle Park, NC.

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RRWG Participant List

American Petroleum Institute
Amway Corporation
Argonne National Laboratory
Atmospheric & Environmental Research, Inc.
Berry Environmental
BKF Solutions
California Air Resources Board
Carbide/Graphite Group
Chemical Manufacturers Association
Chemical Specialties Manufacturers Association
Cosmetic, Toiletry, & Fragrance Association
Desert Research Institute
Dow Chemical Company
Duke Law School
Dunn-Edwards Corporation
DuPont Environmental Excellence Center
Eastman Chemical Company
ENVAIR/Aerochem
Environment Canada
Equilon Enterprises LLC
Exxon Chemical Company
Ford Motor Company
Gemini Coatings, Inc.
Georgia Institute of Technology
GM Research and Development Center
Great Lakes Chemical Corporation
Gulf Coast Hazardous Substances Res. Center
Hogan & Hartson, LLP
Kessler and Associates, Inc
Latham & Watkins
Lyondell Chemical Company
NARSTO
National Aerosol Association
National Paint & Coatings Association
National Renewable Energy Laboratory
NESCAUM
New York State Dept of Environ. Conservation
North Carolina State University
North Carolina Supercomputer Center
Oak Ridge National Laboratory
Occidental Chemical Corporation
Penreco
Radtech International
Reynolds Metals Company
Safety-Kleen
SAI
Shell Chemical Company
Sonoma Technology, Inc.
South Coast Air Quality Management District
SRI International
Texas Natural Resource Conservation Commission
The Aluminum Association
The Proctor and Gamble Company
The Sherwin-Williams Company
Union Carbide Corporation
University of California Riverside
University of Colorado
University of North Carolina at Chapel Hill
University of Texas at Austin
US EPA OAQPS
US EPA NERL
US EPA NVFEL
US EPA Region IX

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