

## **THOMAS R. CARD**

### **Education**

M.S., Civil Engineering, California Institute of Technology  
B.S., Civil Engineering, University of Washington

### **Experience**

Mr. Card is internationally recognized for the assessment and control of odors, air toxics, and volatile organic compounds (VOCs) from waste treatment and industrial facilities. He has written nine books on air emissions and participated in over 150 air quality projects over the last 30 years. He has been the Chairman of the Air Quality Technical Committee of the American Society of Civil Engineers and he has been on the Program Committee for the Water Environment Federation for the Odor and Air Emissions Technical Sessions. He currently provides peer review for both organization's air emissions publications. He is expert in the design and operation of activated carbon systems, biofiltration systems, packed towers, atomized mist systems, and thermal incineration systems. Mr. Card assisted with the development of the BASTE Wastewater Air Emissions Model with Dr. Richard Corsi of the University of Texas. Mr. Card has taught extension classes on air emissions at the University of Texas, University of Wisconsin, and at the WEFTEC Conference.

Mr. Card has worked on air pollution control systems for industrial facilities for the wood products, food processing, chemical manufacturing, oil production, and automotive manufacturing industries. His clients have included Monsanto, Dupont, General Motors, Georgia-Pacific, DomTar, International Paper, Cargill, ConAgra, Pacific Pipeline, Imperial Oil, and Yakama Forest Products.

Mr. Card has recently completed two assessment programs for VOC and ammonia emissions from California Dairies for the California Air Resources Board. These assessments consisted of sampling at two dairies over a two year period for ammonia, total hydrocarbons, and speciated VOCs. In addition to this project, he has completed VOC assessments for the Bay Area Air Quality Management District (5 oil refineries), Alyeska Pipeline Services Company, Los Angeles County Sanitation Districts, NORCAL Waste Systems, and Agri-services.

Mr. Card has completed over 20 air emissions assessment projects for organic waste composting. These include aerated static pile, windrow, vessel technologies composting green waste, biosolids, food waste, and dead cows. He has evaluated the performance of five different compost cover systems. Along with Dr. Charles Schmidt, Mr. Card is the only person to complete a compost emissions compliance test using the SCAQMD Rule 1133 Test Protocol.

Mr. Card has supported the Association of Metropolitan Sewerage Agencies, Chemical Manufacturer's Association, American Petroleum Institute, and the Soap & Detergent Association in the development of national and state air emissions regulations. Mr. Card has worked on wastewater air quality compliance issues with the California Air Resources Board,

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San Joaquin Valley Air Pollution Control District, South Coast Air Quality Management District, Bay Area Air Quality Management District, Puget Sound Clean Air Authority, the Illinois EPA, and several other jurisdictions.

Mr. Card has recently completed a research project with the Water Environment Federation Research Foundation to determine the effectiveness that odor control devices have on other air emissions. Mr. Card also participated in the preparation of the VOC Vapor Phase Control Assessment for the Water Pollution Control Federation Research Foundation. This document was the culmination of nine months of effort to review all available literature involving the characterization and control of wastewater air emissions.

### Professional Registration

Professional Engineer, California and Washington

### Membership in Professional Organizations

Air and Waste Management Association  
American Society of Civil Engineers  
American Society for Testing and Materials

American Water Works Association  
Water Environment Federation  
American Chemical Society

### Books

With T. McMahan, *et al.* **WEF Manual of Practice: Control of Odors and Emissions from Wastewater Treatment.** Water Environment Federation, Arlington, Virginia, 2004.

With G. Adams, *et al.* **Identifying and Controlling Municipal Wastewater Odor: Phase I, Literature Search and Review.** Water Environment Research Foundation, 2003

With P. Tata *et al.* **VOC Emissions from Wastewater Treatment Plants: Characterization, Control, and Compliance.** Lewis Publishers, Boca Raton, FL 2003.

With J. Witherspoon, *et al.* **Odor and Corrosion Prediction and Control in Collection Systems and Wastewater Treatment Plants.** Water Environment Federation, Arlington, Virginia, 2001.

With R. Stuetz, *et al.* **Odours in Wastewater Treatment: Measurement, Modeling, and Control.** IWA Publishing, London, 2001.

With H. Rafson, *et al.* **Odor and VOC Control Handbook.** McGraw Hill, New York, 1998.

With Albert B. Pincince, *et al.* **Toxic Air Emissions from Wastewater Treatment Facilities.** Water Environment Federation, Arlington, Virginia, 1995.

With J. Witherspoon. **Controlling Air Emissions from POTWs: A Guidance Manual for Evaluating Technology.** Water Environment Federation, Arlington, Virginia, 1994.

With T.T. Shen and C.E. Schmidt. **Assessment and Control of VOC Emissions from Waste Treatment Facilities.** Van Nostrand Reinhold, New York, 1993.

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## Papers, Articles, and Presentations

With C. Quigley *et al.* **A Comparison of Three Wastewater Collection System VOC Emissions Models.** Presented at WEFTEC October 2006.

With B. Jensen, *et al.* **Advancing Odor Control to New Levels Gurnee Sewage Treatment Plant North Shore Sanitary District.** Presented at WEFTEC October 2006.

**Innovative Technologies in Odor Control.** Presented at at the Fall 2005 NWEA Fall Conference, November 2005.

With C. Schmidt, *et al.* **Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber.** 14th USEPA Annual Emissions Inventory Conference Las Vegas, Nevada, April, 2005.

With R. Forbes, *et al.* **Impacts of in-plant operational parameters on biosolids odor quality: preliminary results of WERF Phase 2 study.** WEF/AWWA/CWEA Joint Residuals and Biosolids Management Conference and Exhibition: Partnering for a Safe, Sustainable Environment, Baltimore, MD, United States, Feb. 19-22, 2003 (2003),

With R. Forbes, *et al.* **Impacts of the in-plant operational parameters on biosolids odor quality. Final results of WERF odor project Phase 2 field and laboratory study.** WEF/A&WMA Odors and Air Emissions 2004, Specialty Conference, Bellevue, WA, United States, Apr. 18-21, 2004 (2004), 454-467

With G. Adams, *et al.* **Identifying and Controlling the Municipal Wastewater Odor Environment Phase 2: Impacts of In-Plant Operational Parameters on Biosolids Odor Quality.** 2003, Water Environment Research Foundation: Alexandria, VA

With J. Novak, *et al.* **Odor generation patterns from anaerobically digested biosolids.** WEF/A&WMA Odors and Air Emissions 2004, Specialty Conference, Bellevue, WA, United States, Apr. 18-21, 2004 (2004), 521-530.

With M. Higgins, *et al.* **Relationship between biochemical constituents and production of odor causing compounds from anaerobically digested biosolids.** WEF/A&WMA Odors and Air Emissions 2004, Specialty Conference, Bellevue, WA, United States, Apr. 18-21, 2004 (2004), 438-453

**Overview of Odor Control Sampling.** Presented to the Second Bi-annual Odor and Corrosion Specialty Conference and Expo, Texas Water Environment Federation, August 2003.

With C. Schmidt. **Measuring Fugitive Emissions from WWT Processes with Weirs.** Paper No. 78, Air and Waste Management Association Symposium on Air

Quality Measurement Methods and Technology, San Francisco, California, November 13-15, 2002.

With C. Schmidt. **Advantages and Disadvantages of Measuring Flux on Liquid Surfaces Using Flux Chambers and Wind Tunnels.** Paper No. 79, Air and Waste Management Association Symposium on Air Quality Measurement Methods and Technology, San Francisco, California, November 13-15, 2002.

With C. Schmidt, *et al.* **Theoretical and Practical Considerations in the Use of Wind Tunnel for Odor Emission Measurement.** Paper No. 42654, 95th Annual Meeting of the Air and Waste Management Association, Baltimore, MD, June, 2002.

With C. Schmidt. **Estimating Air Emissions from Unit Treatment Processes with Weirs.** Paper No. 43373, 95th Annual Meeting of the Air and Waste Management Association, Baltimore, MD, June, 2002

**Odor & Corrosion - Control Tools Overview.** Presented at the WEFTEC '99 Workshop, Odor and Corrosion Prediction and Control in Collection Systems

With R. Schmidt, *et al.* **Tracer Validation of Odor Dispersion Model.** Presented at the 1998 WEFTEC conference in Orlando.

With J. Witherspoon, *et al.* **60,000 cfm Biofilter for Treatment of Trickling Filter Odorous Emissions.** Presented at the 1998 WEFTEC conference in Orlando.

With J. Witherspoon, *et al.* **WERF: A Critical Review of Odor Control Equipment for Toxic Air Emissions Reduction.** Presented at the 1997 WEFTEC conference in Chicago.

With C.E. Schmidt, *et al.* **Assessment of Odor Emissions Using the USEPA Flux Chamber and Olfactory Odor Measurement.** Presented at the 89th Annual AWMA Meeting Nashville, TN, June 1996.

**Air Emissions from Wastewater Aeration Systems.** Presented at the 89th Annual AWMA Meeting Nashville, TN, June 1996.

With J. Witherspoon, *et al.* **Control and Production of Toxic Air Pollutants at POTW Odor Control Equipment.** Presented at the 88th Annual AWMA Meeting San Antonio, TX, June 1995.

With G. Mayer, *et al.* **An Overview of the Tri-TAC Guidance Document on Control Technologies for VOC Air Emissions from POTWs.** Presented at the 88th Annual AWMA Meeting San Antonio, TX, June 1995.

**Comparison of Mass Transfer Models with Direct Measurement for Free Liquid Surfaces at Wastewater**

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**Treatment Facilities.** Presented at the 88th Annual AWMA Meeting San Antonio, TX, June 1995.

With B. Desing, **Something Is in the Air, or Is It?** Industrial Wastewater, Volume 2, Number 5, September 1994.

With G. Mayer, et al, **Development of a Control Technology Guidance Document for VOC Emissions Reduction.** Presented at the 1994 WEFTEC conference in Chicago.

With J. Witherspoon, et al, **Assessment of efficiencies of odor scrubbers for VOC Control.** Presented at the 1994 Water Environment Federation Conference Specialty Conference in Jacksonville, FL.

With A. Michiels, et al, **An Updated Hydrogen Sulfide Fate Model for Wastewater Collection Systems.** Presented at the 1993 Water Environment Federation Conference.

**Sources and Control of VOCs in Wastewater Treatment Systems.** Presented at the 1993 ASTM Environmental Conference in Montreal.

With S. Van Slyke, M.I. Rumpf, and L. Ellington. **An Emissions Mission: Air Quality Permit Issues for Wastewater Treatment Plants.** Water Environment Technology, Vol. 5, No. 10, October 1993.

With M. McAfee, T. Cork, and F. Kessler. **The Effects of Chemical Odors at a Wastewater Treatment Plant During Canning Season.** Paper 93-MP-19.05 at the 1993 AWMA Conference, Denver, CO.

With Stopenhagen, K.W., and M.D. Schaaf. **Physical Modeling for Odor Control and Stack Height Determination at the METRO West Point Wastewater Treatment Plant.** Presented at the 1993 AWMA Conference, Denver, CO.

With Bill Desing. **Quantification of Air Emissions from Wastewater Treatment Plants.** Presented at the 1992 Water Environment Federation Conference.

With P. Benson. **Modeling the Air Emissions from an Industrial Wastewater Treatment Facility.** Presented at the 1992 AWMA Convention, Kansas City, MO.

With R. L. Corsi. **A Flexible Fate Model for VOCs in Wastewater.** Water Environment and Technology, March, 1992.

With K. A. O'Neill, et. al. **Process Modifications to Reduce VOC Emissions From Wastewater.** Presented at the 1991 Air and Waste Management Association Meeting.

With R. L. Corsi. **VOCs in Wastewater: State of Understanding.** Presented at the 1991 Air and Waste Management Association Meeting.

With J. R. Witherspoon. **California Assembly Bill 2588 Impacts on POTWs.** Presented at the 1991 Air and Waste Management Association Meeting.

With R. L. Corsi. **A Multi-Process General Fate Model for VOCs in Wastewater.** Presented at the 1991 Air and Waste Management Association Meeting.

With R. L. Corsi and J. Witherspoon. **Toxic Air Contaminant Emissions From Wastewater: Estimation Methods.** Presented at the International Conference on Air Toxics Issues in the 1990s: Policies, Strategies, and Compliance, April 1991.

With W. R. Faught and J. A. Nottoli. **POTWs, Air Toxics, and AB2588: An Emission Estimation Program.** Presented at the Air and Waste Management Association West Coast Region Air Toxics Conference, October 1990.

With C. Gatlin and D. Griffes. **Air Toxics at POTWS.** Presented at the 1990 CWPCA.

**Design of Wastewater Treatment Plants to Minimize Air Emissions.** Presented at the 1990 AIChE National Meeting, San Diego, California.

**VOC Removal in Absorption Odor Control Systems.** Presented at the 1990 ASCE Specialty Conference on Environmental Engineering, Arlington, Virginia.

**Volatile Organic Compound Removal in Packed Towers and Atomized Mist Odor Scrubbing Systems.** Presented at the 1989 Annual Water Pollution Control Federation Conference.

With B. Gravette and K. Hood. **An Overview of Odor Control Systems.** Presented at the 1989 Annual Pacific Northwest Pollution Control Association Conference.

With M. Schaaf. **An Investigation of Odor Impact Downwind of Seattle Metro's West Point Wastewater Treatment Plant.** Presented at the 1989 Annual Pacific Northwest Pollution Control Association Conference.

With R. L. Purdom. **Ozone Demand and Decay (Natural and Hydrogen Peroxide Assisted) in Upper Columbia River Water.** Presented at the IXth Annual World Ozone Congress, June 3, 1989.

With C. M. Morton. **Design of Packed Towers for Odor Control.** Presented at the 1987 Annual Water Pollution Control Federation Conference.

With C. M. Morton and W. D. Byers. **Treatment of Contaminated Groundwater by Air Stripping and Carbon Adsorption.** Presented at the 1984 Annual Water Pollution Control Federation Conference.