Detection Technologies for Chemical Warfare Agents and Toxic Vapors

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Preface

Terrorists have used toxic chemicals and high-powered explosives on many occasions. Examples include bombing of the World Trade Center in 1993, deployment of the chemical agent sarin in the Tokyo subway system in 1995, and the bombing of the Oklahoma City Federal Building in the same year. The events of September 11, 2001, in New York City and Washington, D.C., changed the lives of people in the U.S. as well as in many other nations throughout the world.

Sarin is one of several toxic chemicals defined as weapons of mass destruction (WMDs). WMDs "are capable of a high order of destruction and/or of being used in such a manner as to destroy large numbers of people. Weapons of mass destruction can be high explosives or nuclear, biological, chemical, and radiological weapons, but exclude the means of transporting or propelling the weapon where such means is a separable and divisible part of the weapon. Among weapons of massive destruction, besides high explosives, are the chemical, biological, and nuclear weapons" (*Dictionary of Military and Associated Terms*, U.S. Department of Defense, Joint Publication, 2002). Use of WMDs, such as nuclear, biological, or chemical weapons by terrorists toward civilian targets, will cause large numbers of casualties. The recent anthrax episode in the U.S. is a prime example of how a biological agent could cause casualties and fear. The anthrax incidents together with the Tokyo subway incident, which killed more than ten people and injured thousands, shocked the world into awareness that even a small-scale deployment of these WMDs could cause chaos. The use of WMDs against civilian targets is no longer unlikely, nor is any country today spared from such terrorist acts. The potential use of chemical warfare agents (CWAs) and/or toxic industrial compounds (TICs) by terrorist groups has increased substantially in recent years.

CWAs are relatively inexpensive to manufacture. Release of these agents could be carried out surreptitiously, with the first awareness of exposure occurring when victims develop symptoms. The U.S. government has attempted to tighten controls on these compounds and necessary reagents for their syntheses. There are, however, many other compounds used in industries that are also quite toxic. These toxic industrial compounds or chemicals (TICs) are readily available in large quantities. Although they are less toxic compared to conventional CWAs, their availability in large quantities has made them attractive to terrorist groups.

Given that terrorists can synthesize CWAs or easily obtain large amounts of TICs, the threat of using CWAs or TICS at any time toward government or civilian targets is cause for great concern. It is not possible to predict when incidents may happen, regardless how much effort is spent in prevention. Therefore, fast and reliable equipment to detect the existence of these compounds in the air is critically needed to offer protection when such incidents occur. Authorities around the world are searching for effective rapid detection of airborne CWAs or TICs to permit orderly evacuation of exposed areas to minimize potential casualties.

We have been involved in testing and evaluation of CWA detection devices that include most of the existing point-sampling detectors for many years. It is hoped that this book will help the general public as well as decision makers in the public and private sectors to understand methodologies employed for the detection of toxic chemicals. This book provides pertinent physical, chemical, and toxicological information of the more dangerous compounds that can kill or cause severe injuries. We condense information about detection requirements, discuss U.S. government policies, explain various technologies used in detecting CWAs and TICs, and summarize the characteristics of many current detection devices. We have also included vapor generation techniques and analytical methodologies with recommendations on preferred apparatus and instrumentation for efficient laboratory evaluations of detection devices. We provide reasonably up-to-date information on toxic vapor detection with special emphasis on CWAs, which is also applicable to TICs.

We have attempted to provide as much useful information as possible on existing detection technologies. Time and space constraints prevented us from including all existing devices and methodologies; our discussion is then limited to the most common ones that we have encountered. Inclusion of these relatively common devices and methodologies does not mean that the U.S. government (or any other government) endorses them, or that we endorse them.

Acknowledgments: We could never have completed this book without the help of many people. We are especially grateful for the understanding and support of our families. Suggestions and advice from many reviewers are also greatly appreciated.

Authors

Yin Sun was born in XuZhou, JiangSu, China. He earned his B.S. degree at Nanjing University and his M.S. degree from the ChengDu University of Technology. He was awarded the Ph.D. degree by the University of Connecticut. Sun has worked in the areas of analytical chemistry, environmental chemistry, application chemistry, and analytical instrumentation for about 20 years. In the early stage of his career, he was interested in the geochemical behavior of noble metals, such as gold and silver. His research focused on finding valuable deposits using trace element distributions and combinations. Later, environmental issues, especially heavy metal pollution, became the focus of his research. His research centered on using radioactive isotopes as tracers for the behavior of heavy metals in estuaries. During this period, he developed new analytical techniques for the tracers he was using, and conducted many studies using various modern instruments.

Several years ago, Sun turned his attention to developing analytical methods for the detection and analysis of explosives and illegal drugs in various matrices. He then spent a number of years studying the detection of toxic industrial compounds and chemical warfare agents (CWAs). Sun has developed vapor generation systems and tested various techniques for the detection of TICs. Since CWAs are strictly controlled, he has spent much time in the U.S. Army Edgewood Chemical Biological Center (ECBC) laboratory. While working at the ECBC, his "second home," he met Kwok Y. Ong

Kwok Y. Ong received his B.S. degree in chemistry from California State University at Los Angeles. He was drafted into the U.S. Army immediately upon graduation and was assigned to the Edgewood Arsenal, headquarters of the Chemical Corps under the Science and Engineering Program. He remained at Edgewood as a civilian employee after discharge from the military until his retirement from the civil service in September 2001. He is currently associated with the EAI Corp., in which capacity he provides continued support to the government with special emphasis on CWA detection and detector evaluations.

Ong has extensive work experience with practically all point-sampling detectors, starting with the U.S. military's M43 to the current ACADA, and including many evaluations of devices for the Domestic Preparedness program that were either developed in-house or abroad. He has patented vapor generation techniques and analytical methodologies that have become industry standards. Ong is a greatly respected expert in the field of toxic chemical detection. People refer to testing at the ECBC as in "Kwok's laboratory." His recommendations are considered authoritative.

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