Removal of Volatile Organic Chemicals from Potable Water

Technologies and Costs

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REMOVAL OF VOLATILE ORGANIC CHEMICALS FROM POTABLE WATER

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Foreword

This book reviews technologies for the removal of volatile organic chemicals (VOCs) from potable water and provides cost estimates for these technologies. The information provided is intended to assist in identifying the best treatment methods, taking costs into account and pursuant to the Safe Drinking Water Act, for use by public water systems to remove volatile synthetic organics from contaminated water sources.

Generally, the most economical and effective treatment and compliance methods include modification of existing treatment systems, installation of new systems, or the selection of other water sources. Whichever method or combination of methods is selected depends on case-by-case evaluation of a particular user's needs.

The book provides those engineers and managers involved in decision-making for water treatment systems with necessary information on various treatment methods currently in use for removal of VOCs at various concentration levels. It also provides some nontreatment alternatives, as well as relative costs. This book should prove to be a valuable document for those interested in removing and/or required to remove VOCs from drinking water.

The information in the book is from *Technologies and Costs for the Removal of Volatile Organic Chemicals from Potable Water Supplies,* prepared by Environmental Science and Engineering, Inc. for the U.S. Environmental Protection Agency, May 1985.

The table of contents is organized in such a way as to serve as a subject index and provides easy access to the information contained in the book.

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Contents and Subject Index

1. Introduction

This document is designed to assist with the identification of the best treatment methods or other means that the Administrator of the United States Environmental Protection Agency (EPA) finds to be generally available, taking costs into consideration, pursuant to the Safe Drinking Water Act (SDWA), for use by public water systems in removing volatile synthetic organic chemicals (VOCs) from contaminated water sources. EPA is currently proposing maximum contaminant levels (MCLs) for the VOCs most prevalent in contaminated water supplies, shown in Table 1-1. The treatment and compliance methods available to a community searching for the most economical and effective means to comply with proposed VOC MCLs include modification of existing treatment systems, installation of new systems, and the selection of other water sources.

It is not the intention of EPA to require any system to use a particular treatment method to achieve compliance with proposed VOC MCLs. Instead, the responsibility is retained by the individual water systems to select one or more procedures that are optimal for their particular water supply situation. Whichever individual method or combination of treatment methods is ultimately selected by a water supplier must be based upon a case-by-case technical evaluation of the system's entire treatment process, and an assessment of the economics involved. However, the major factors that must be considered include:

1. Quality and type of water source,
2. Degree of VOC contamination,
3. Specific compound(s) present in water source,

Table 1-1. List of VOCs for Which MCLs Are Being Considered

Trichloroethylene
Tetrachloroethylene
Carbon Tetrachloride
1,2-Dichloroethane
Vinyl Chloride
1,1-Dichloroethylene
Benzene
1,1,1-Trichloroethane
p-Dichlorobenzene

Source: Federal Register, June 12, 1984.

4. Economies of scale and the economic resources available to the community being served,
5. Treatment and waste disposal requirements, and
6. Control of air emissions of VOCs.

The information provided in this document is intended to aid a system in selecting the best treatment method for providing a water free from or with acceptable concentrations of VOCs. It provides the user with an evaluation of the various treatment methods in use today for the removal of different concentrations of VOCs and several nontreatment alternatives, as well as relative costs. The methods that can be applied are divided into three general categories:

Most Effective Treatment Technologies--Technologies that are generally available, have a demonstrated highly effective capacity to remove VOCs, and for which reasonable cost estimates can be developed for a wide range of influent/effluent conditions.

Other Treatment/Alternative Technologies--Nontreatment or compliance measures, such as new sources or regionalization, or technologies which are less efficient or may not be applicable to all plants.

Additional Technologies--Technologies which experimentally have been shown to have potential for removing VOCs, but for which insufficient data exist to fully evaluate the technology.

For waters contaminated with VOCs, the following treatment technologies are designated as the Most Effective Treatment Technologies for all of the system size categories (June 12, 1984, CFR Vol. 49, No. 114):

1. Packed tower aeration, and
2. Granular activated carbon (GAC) adsorption.

Costs estimates developed for the Most Effective Treatment Technologies for the influent/effluent conditions shown in Table 1-2 for each of the 12 system size categories shown Table 1-3 are presented in Section 7.1.

Table 1-2. Influent/Effluent Concentrations for Estimating Costs for Most Effective Treatment Technologies

Chemical	Influent Concentrations (ug/L)*	Effluent Concentrations (ug/L)
Trichloroethylene	500,200,100,50,25,10,5	1,5,10,25,50,100
Tetrachloroethylene	500,200,100,50,25,10,5	1,5,10,15,25,50,100
Carbon tetrachloride	500,200,100,50,25,10,5	1,5,10,25,50,100
1,2-Dichloroethane	500,200,100,50,25,10,5	1,5,10,25,50,100
Vinyl chloride	500,200,100,50,25,10,5	1,5,10,25,50,100
1,1,-Dichloroethylene	500,200,100,50,25,10,5	1,5,10,25,50,100
Benzene	500,200,100,50,25,10,5	1,5,10,25,50,100
1,1,1-Trichloroethane	500,200,100	5,10,200
p-Dichlorobenzene	1,000,500	5,10,750

* ug/L = micrograms per liter.

Table 1-3. Population Ranges and Respective Flow Rates

Category	Population Range	Average Flow Rate
1	25-100	13,000 gpd*
2	101-500	37,000 gpd
3	501-1,000	93,000 gpd
4	1,001-3,300	280,000 gpd
5	3,301-10,000	952,000 gpd
6	10,001-25,000	2.753 MGD†
7	25,001-50,000	6.065 MGD
8	50,001-75,000	11.680 MGD
9	75,001-100,000	15.912 MGD
10	100,001-500,000	36.806 MGD
11	500,001-1,000,000	129.421 MGD
12	>1,000,000	517.491 MGD

* gpd = gallons per day.
† MGD = million gallons per day.

Table 1-2 presents the influent and effluent concentrations used for estimating removal cost. The influent concentrations provide an approximation of the range of concentrations likely to occur in drinking water systems considering treatment. The effluent concentrations are hypothetical MCLs.

The following have been designated as Other Treatment/Alternative Technologies:

1. Multiple-tray aeration,
2. Diffused aeration,
3. Spray aeration,
4. Air-lift pumping,
5. Cascade aeration,
6. Mechanical aeration,
7. Powdered Activated Carbon (PAC) Adsorption,
8. Well field management,
9. Bottled water,
10. Regionalization, and
11. Alternate source.

Cost estimates developed for Other Treatment/Alternative Technologies for the 12 system size categories shown in Table 1-3 are presented in Section 7.2.

Additional Treatment Technologies include the following:

1. Point-of-use and point-of-entry devices, home carbon adsorption units, distillation units;
2. Point-of-use and point-of-entry devices, home reverse osmosis units; and
3. Ozone plus ultraviolet (UV) radiation.

Cost estimates developed for Additional Treatment Technologies are presented in Section 7.3.

2. Background

The water supply testing programs conducted by federal, state, and local government agencies have identified VOC contamination of water supplies as a widespread occurrence warranting evaluation of potential health effects and requiring regulatory action. On March 4, 1982, EPA published an Advanced Notice of Proposed Rulemaking (ANPRM) in the Federal Register regarding proposed regulation of VOCs in drinking water.

Four workshops on the proposed VOC regulations were subsequently funded by the EPA Office of Drinking Water (ODW) and conducted jointly by EPA and the American Water Works Association Research Foundation (AWWARF) during July through August 1982. The purpose of the workshops was to inform representatives of water utilities, related industries, state regulatory agencies, local officials, environmental and public interest organizations, and other interested parties of the data EPA had gathered and the regulatory approaches it was considering and to generate discussion, comments, and recommendations on the data and possible control measures. The leaders of the workshops were nationally recognized authorities in water treatment, chemistry, toxicology, and process design. The workshops provided both valuable communication between various interested groups and input to the regulatory process.

The overall consensus of the workshops was that contamination by VOCs is a national problem warranting action. Establishment of MCLs and monitoring programs was recommended, provided the health effects data are valid and indicate the need to reduce human exposure to VOCs.

The workshops pointed out potential problems which could arise under various regulatory scenarios. EPA has attempted to address as many of the concerns raised during the workshops as possible in its implementation and promulgation of the VOC regulation.