

# Organic Chemicals

## Session Objectives

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- To demonstrate the range of organic chemicals that may be found in drinking-water and describe the sources of such chemicals.
- To describe the health risks associated with the consumption of drinking-water containing organic contaminants.
- To highlight the taste and odour problems associated with organic contamination.

# Organic Chemicals

## **Introduction**

Specific chlorinated alkanes, chlorinated ethylenes, aromatic hydrocarbons, chlorinated benzenes, and miscellaneous organic chemicals were evaluated in the 1993 WHO *Guidelines for Drinking-Water Quality*.

Many of these organic chemicals are widely used as solvents, in chemical synthesis, in petroleum products, and in the production of plastics and resins. Some 30 organic chemicals were evaluated and guideline values (GV), or provisional guideline values, recommended for 27 of these.

Some organic substances do not have a 'no observed adverse effect limit' (NOAEL) - the highest concentration of a substance which causes no detectable adverse health effect. Therefore for some substances, a provisional guideline has been set on the basis of the 'lowest adverse effect limit' (LOAEL) - the lowest concentration or dose of a substance where there is a detectable adverse effect. Where a LOAEL is used, an additional uncertainty factor (UF) - a measure of the uncertainty regarding the information about a substance - is used. For further information, please refer to the background paper for Session II of this teaching pack or to the *Guidelines Volume 1 and 2*.

Adequate toxicological data were not available to derive guideline values for a number of chemicals, including 1,1-dichloroethane, 1,3-dichlorobenzene, dialkyltins, and a number of polynuclear aromatic hydrocarbons, with the exception of benzo[a]pyrene.

For most of the aromatic hydrocarbons and chlorinated benzenes, the taste and/or odour thresholds of these chemicals are well below the health-based guideline values, thus constituting an assurance that the GVs would not be exceeded or even approached. Consumers complaints would constitute a safety net against such a situation.

A number of organic chemicals were considered to be genotoxic and carcinogenic and the linearized multistage extrapolation model was used to derive guideline values corresponding to an upper bound estimate of an excess cancer risk of  $10^{-5}$ .

For most organic chemicals that show a threshold for toxic effects, little was known of the magnitude of exposure from drinking-water relative to other sources. Consequently, the default value of 10% of the TDI was allocated to drinking-water.

Nitritotriacetic acid (NTA) is a compound used in detergents, and tributyltin oxide (TBTA) is used in boat paints. Substantial exposure may occur from drinking-water, and consequently 50% and 20% of the TDI was allocated to drinking-water for NTA and TBTA respectively.

Di(2-ethylhexyl)adipate and di(2-ethylhexyl)phthalate are used in food-contact materials and therefore exposure from food is expected to be high. Therefore, only 1% of their respective TDI was allocated to drinking-water.

Because of their general persistence in the environment and concern over their potential toxicity, a large number of the organic chemicals evaluated are chlorine-containing chemicals.

For further information please see the *Guidelines for Drinking Water Quality* Volumes 1 and 2.

# Organic Chemicals

## Presentation Plan

Section	Key points	OHP
<b>Introduction</b>	<ul style="list-style-type: none"><li>• there are many organic chemicals that may be found in drinking water</li><li>• these are very diverse in nature</li><li>• many organic chemicals found in water are derived from industry</li></ul>	<b>1,2, 3</b>
<b>The Guidelines</b>	<ul style="list-style-type: none"><li>• the <i>Guidelines</i> review some specific organic chemicals</li><li>• a total of 30 organic substances reviewed and Guideline derived for 27 of these (inadequate data on the others)</li></ul>	<b>4</b>
<b>Exposure from drinking-water</b>	<ul style="list-style-type: none"><li>• for most organics, there is little information available on exposure from drinking-water relative to other sources, therefore have high uncertainty factors</li><li>• often use a LOAEL rather than a NOAEL as many non-threshold organic substances</li></ul>	
<b>Genotoxic &amp; carcinogenic organics</b>	<ul style="list-style-type: none"><li>• some organics are considered genotoxic and carcinogenic</li><li>• linearized multistage extrapolation model used to derive GVs corresponding to <math>10^{-5}</math> excess risk</li><li>• most aromatic hydrocarbons and chlorinated benzenes have taste and odour thresholds well below health-based Guideline Values, a margin of safety therefore exists</li></ul>	

# Example of Organic Pollutants by Class and Typical Use 1

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- Halogenated aliphatic (chain) hydrocarbons
  - » Trihalomethanes (THMs) may be formed during disinfection of drinking-water; other compounds used as solvents for decaffeinating coffee, general solvents and in products such as propellant, degreasers, spot removers and dyes
- Aromatic (ring) hydrocarbons
  - » Many products derived from fossil fuels, also as additives in petrol, moth balls, adhesives and cigarette smoke
- Chloro- and nitro-aromatic hydrocarbons
  - » Fungicides and explosives
- Phthalates
  - » Phthalates are added to plastic to make them flexible; found in rain wear, footwear, shower curtains, childrens toys



## Example of Organic Pollutants by Class and Typical Use 2

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- Halogenated ethers
  - » Halogenated ethers are used in production of plastics and resins and in research laboratories
- Phenols
  - » Fungicide; wood preservative; Chloro-dichloro-, trichloro-phenols are by-products in the production of pentachlorophenol
- Organochlorines
  - » DDT, lindane, aldrin and chlorodane are examples of the extremely persistent organochlorine pesticides widely used in the 1950s and 1960s.

# The Breakdown of Organic Compounds

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- Enter water from a variety of sources including:
  - » Human/animal wastes
  - » Plants
  - » Soil erosion
  - » Industrial wastes
- Generally unstable, may be oxidised to stable and relatively inert end products e.g.  $\text{CO}_2$ ,  $\text{NO}_3$ ,  $\text{H}_2\text{O}$
- Oxidation: loss of electrons to an oxidising agent such as oxygen or chlorine which accepts electrons
- Oxidation of organic compounds occurs in aerobic or anaerobic conditions
- Quantity of organic material and the quantity of oxygen needed to oxidise it estimated by using:
  - » Biochemical oxygen demand (BOD)
  - » Permanganate value (PV)
  - » Chemical oxygen demand (COD)



## Organics reviewed in the *Guidelines*

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- A total of 30 organic substances reviewed in the following groups:
  - » Chlorinated alkanes (5 substances)
  - » Chlorinated ethenes (5 substances)
  - » Aromatic hydrocarbons (6 substances)
  - » Chlorinated benzenes (5 substances)
  - » Miscellaneous organic constituents (9 substances)