
Institute for Environment and Health

# Volatile organic compounds (including formaldehyde) in the home

This document contains text prepared in 1999 by the Institute for Environment and Health for a leaflet to be published by DETR. The leaflet is primarily intended for use by Environmental Health Officers when giving advice to members of the public.

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## Introduction

This leaflet has been prepared by the Institute for Environment and Health, on behalf of the Department of the Environment, Transport and the Regions, to provide Environmental Health Officers with information to answer questions from concerned members of the public about a group of chemicals known as volatile organic compounds (VOCs).

This leaflet covers the nature of VOCs and describes the levels that would be expected in UK homes, based on extensive data collected by the Building Research Establishment. The health effects that might result from exposure to some specific VOCs are also examined. Issues such as the responsibility of EHOs and local authorities for dealing with VOCs, current UK regulations and controls of these chemicals, together with the types of products that may contain VOCs and suitable alternatives to VOCs are discussed. A section containing commonly asked questions about VOCs in the home, with appropriate answers, is included at the end of the leaflet.

## What are volatile organic compounds?

VOCs form a large, diverse group of organic chemicals that are gaseous at room temperature (although the specific meaning of the term VOCs can depend on the analytical methods used to measure them). The World Health Organisation classes VOCs as the group of organic compounds occurring in air that have a boiling temperature of between 50–100 °C and 240–260 °C. However, this classification varies (see Annex 3 for a list of VOCs and their respective boiling points, according to the European Collaborative Action Steering Committee on Indoor Air Quality (ECA)). Although not falling within this definition, formaldehyde is usually considered together with VOCs. It is included in this advice leaflet as it is of a particular health concern.

VOCs can be found in a wide variety of materials in the home (see Table 1).



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**Table 1 Some specific indoor sources of VOCs**

| VOC | Source material(s) |
|---|---|
| Formaldehyde | Environmental tobacco smoke, urea formaldehyde foam insulation (UFFI), particle board, chipboard, plywood, water-based paints, fabrics, household cleaners |
| *p*-Dichlorobenzene | Moth crystals, room deodorants |
| Styrene | Insulation, textiles, disinfectants, plastics, paints |
| Benzyl chloride | Vinyl tiles |
| Benzene | Environmental tobacco smoke |
| Tetrachloroethylene | Dry-cleaned clothes |
| Chloroform | Chlorinated water |
| 1,1,1-Trichloroethane | Dry-cleaned clothes, aerosol sprays, fabric protectors |
| Carbon tetrachloride | Industrial strength cleaners |
| Aromatic hydrocarbons (toluene, xylenes, ethylbenzene, trimethylbenzenes), aliphatic hydrocarbons | Paints, adhesives, petrol, combustion products |
| Terpenes (limonene, α-pinene) | Scented deodorisers, polishes, fabrics, fabric softeners, food, beverages, environmental tobacco smoke |
| Polycyclic aromatic hydrocarbons | Combustion products (smoking, woodburning, kerosene heaters) |
| Acrylic acid esters, epichlorohydrin, alcohols | Monomers may escape from polymers aerosols, window-cleaners, paints, paint thinning, cosmetics and adhesives |
| Ketones | Lacquers, varnishes, polish removers, adhesives |
| Ethers | Resins, paints, varnishes, lacquers, dyes, soaps, cosmetics |
| Esters | Plastics, resins, plasticisers, lacquer solvents, flavours, perfumes |

From IEH (1996)

## Levels of VOCs in homes

In 1992, the Building Research Establishment (BRE) carried out an extensive survey of VOCs and other indoor air pollutants in the Bristol area, associated with the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC). This study monitored levels of a number of VOCs and formaldehyde in 173 homes, for one year. The monitoring data were used together with questionnaire data on occupancy and activity to assess the levels of pollution in the homes and the causes of variation in pollutant levels. A summary of the data on total VOCs and selected specific VOCs is presented in Table 2. From this table it can be seen that for some VOCs, such as benzene and toluene, there is the possibility that some sources outside of the home contribute to levels in homes.

## Potential effects of VOCs on health and well-being

The majority of individual VOCs that make up the spectrum of VOCs found in the air of UK homes have no reported health effects, even at levels orders of magnitude higher than those found in homes. These VOCs include aliphatic hydrocarbons such as undecane, most aromatic hydrocarbons such as toluene, esters and alcohols. There have been reports of exposure to VOCs that lead to sensory effects and general discomfort due to strong odours, and irritancy or allergic reactions. At extremely high levels of exposure headaches, eye and throat irritation, nausea, dizziness and drowsiness are some of the symptoms that may be experienced. Individuals with existing respiratory diseases, such as asthma or allergy, may be particularly susceptible and may react to VOC exposure at levels below those that would affect healthy individuals. A few VOCs are known to pose health risks at lower exposures and these are considered below.

A small number of VOCs found at low concentrations in indoor air are recognised carcinogens. Some, such as benzene, are genotoxic* and no absolutely safe level of exposure can be defined. However, at the concentrations measured in most of the homes studied, the risk to health from these compounds is negligible. In most homes the annual average concentration of benzene is less than that recommended as the standard for outdoor air quality (16.2 μg/m$^3$ running annual

* Genotoxic - damaging to DNA

**Table 2 Mean annual concentrations and percentile values of TVOCs (µg/m³) and selected compounds**

| | Concentration | | | | | Percentile concentration | |
|---|---|---|---|---|---|---|---|
| Compound | n | Mean | SD | Minimum | Maximum | 50th | 95th |
| **TVOCs** | | | | | | | |
| Bedroom | 173 | 415 | 323 | 40 | 2051 | 308 | 1064 |
| Living room | 173 | 406 | 314 | 51 | 1799 | 296 | 1077 |
| Outside | 13 | 40 | 30 | 14 | 120 | - | - |
| **Benzene** | | | | | | | |
| Bedroom | 173 | 8 | 4 | 2 | 32 | 7 | 14 |
| Living room | 173 | 8 | 6 | 2 | 46 | 7 | 15 |
| Outside | 13 | 5 | 1 | 3 | 8 | - | - |
| **Toluene** | | | | | | | |
| Bedroom | 173 | 40 | 86 | 8 | 1044 | 25 | 73 |
| Living room | 173 | 47 | 124 | 10 | 1583 | 28 | 81 |
| Outside | 13 | 12 | 11 | 5 | 45 | - | - |
| **Xylenes** | | | | | | | |
| Bedroom | 173 | 27 | 23 | 2 | 203 | 20 | 69 |
| Living room | 173 | 26 | 25 | 3 | 250 | 19 | 69 |
| Outside | - | - | - | - | - | - | - |
| **Undecane** | | | | | | | |
| Bedroom | 173 | 14 | 17 | 0 | 104 | 9 | 43 |
| Living room | 174 | 14 | 16 | 0 | 91 | 9 | 50 |
| Outside | 1 | 0 | 0 | 0 | 1 | - | - |
| **Formaldehyde** | | | | | | | |
| Bedroom | 174 | 25 | 20 | 1 | 4 | 20 | 50 |
| Living room | 174 | 23 | 13 | 4 | 76 | 19 | 46 |
| Outside | 14 | 2 | 1 | 1 | 4 | - | - |

From BRE (1996)

TVOC, total VOC; -, not measured/determined

average concentration) by the Expert Panel on Air Quality Standards (EPAQS) and adopted in the National Air Quality Strategy.

Formaldehyde is measured using a different methodology and is often singled out from other VOCs. Most people will show no effects from exposure to an ambient maximum concentration of 100 µg/m³ averaged over 30 minutes, though some individuals may show transient effects at or below this level. Combined exposure to any other irritant substance, whether a VOC or not, may alter sensory reactions to formaldehyde.

# Advice for the public

The advice provided below is designed to assist Environmental Health Officers when responding to queries from members of the public concerning volatile organic compounds. This advice is split into three sub-sections: general advice on the health effects of VOCs and how exposures may be reduced, specific issues which may need to be addressed, and a question and answer section covering some of the most common queries.

## General advice

- According to the Department of Health Committee on the Medical Effects of Air Pollutants, there is no evidence to suggest that current UK domestic exposures to VOCs, either as individual chemicals or as a total, pose a risk to health. The contribution of VOCs towards carcinogenic[a], mutagenic[b] and neurotoxic[c] effects in the UK population is considered negligible.

- The odours associated with VOCs may nevertheless be unpleasant and the sources of those VOCs should therefore be identified and, where possible, removed. Where removal of the source is not possible, for example aromatic hydrocarbons from a painted room, ventilation should be increased.

[a] Carcinogenic - cancer causing

[b] Mutagenic - causes mutations to genetic material

[c] Neurotoxic - toxic to nerve tissue

- Particular activities, such as painting, DIY and hobbies using solvent based glues, may be associated with unusually high levels of VOCs. Ensure that there is adequate ventilation when using these products. Occupants who may be sensitive to VOCs, such as asthmatics or those with allergies, should avoid using the products and keep away from affected rooms. Alternatively, water-based and low VOC-emission products may be used.

- Unknown sources of odour in a house may be due to emission of VOCs, but this is not always the case. Suspected VOC emissions may be confused with other problems, such as faulty gas appliances, and so the possibility of other pollutants being the cause of odours should always be considered.

- If a problem with VOCs is suspected, first consider whether there are any obvious explanations, such as recent decorating, building or DIY work. Increase ventilation in the affected rooms by opening windows, vents or extract fans. If odours persist and the source of VOCs cannot be identified, monitoring may be undertaken. This could identify the main VOCs present, help to single out the source of the odour and thereby enable remedial action to be taken.

## Specific issues

### *Susceptible groups*

Some individuals may be more sensitive to peak exposures to VOCs due to existing chronic diseases or allergies. Exacerbation of respiratory symptoms or allergic reactions may result. These people should take the general advice provided above to minimise their exposure to VOCs.

In extreme cases individuals may show reactions to VOCs at very low, long-term levels of exposure, although there is a lack of data to substantiate this. There are also individuals who appear to react adversely to a large range of chemicals at relatively low concentrations. This condition is sometimes termed ‘multiple chemical sensitivity’, and may possibly be induced by an initial exposure at a very high level. In some cases these types of reaction may be connected with psychological conditions, and the advice of a medical professional should be sought.

Pregnant women and young babies should avoid exposure to high levels of VOCs. Whilst there is no direct evidence that VOCs have an effect on the fetus or the baby it is prudent to minimise exposure wherever possible. Practical advice should include avoiding the use of paint or other DIY materials containing solvents in the home in the last few months of pregnancy or the first few months after birth.

### *Responsibilities of local authorities and EHOs*

Without evidence of the probability of harm resulting from exposure to VOCs within the home, the formal responsibilities of local authorities, and of EHOs in particular are few, if any. Under the current standard, houses will not be unfit by reason only of poor indoor air quality (though that might indicate deficiencies in their state of repair and in their ventilation) and though VOCs, perhaps particularly because of their odour, are capable of giving rise to nuisances at common law level, they will not amount to statutory nuisances while they affect only persons of abnormal sensitivity. Various VOCs in the hands of contractors may be subject to control under the Health and Safety at Work etc Act 1974 and the COSHH Regulations, but these will be enforced by the Health and Safety Executive. Authorities lacking suitable equipment for detecting VOCs, or expertise in-house should make adequate provision for consultants in their budgets (Annex 1).

### *Emission control activities (Annex 2)*

There have not been any direct attempts to control VOC emissions from building and consumer products. However, there are a number of voluntary labelling schemes that enable consumers to choose products with lower emissions. For example, B&Q stipulate that paints and varnishes must be labelled for VOC content, using the B&Q classification, before they are sold from any of their branches.

### *Alternatives to VOC-containing products*

An increasing number of paint products are being labelled for VOC content. The number of paints that are water based with high solid and low VOC content is also increasing, thus widening consumer choice. Although it is possible that the performance of these alternative products is not as good as those with a higher VOC content.

### *Urea-formaldehyde foam insulation (UFFI)*

Urea-formaldehyde foam Insulation, a cellular matrix of urea-formaldehyde resin, has been installed in the cavity walls of approximately 2 million buildings in the UK. The current installation rate in the UK is much reduced from that of the early to mid 1980s, before the negative publicity regarding formaldehyde related problems began. Research by BRE showed that the mean aldehyde concentrations in homes insulated with

UFFI was 114 µg/m$^3$ compared with 57 µg/m$^3$ in homes not insulated using this product. Emissions are at their greatest immediately after the product is installed. Formaldehyde release thereafter decreases depending on the quantity of free volitisable unreacted formaldehyde trapped in the resin and on the hydrolytic decomposition or ageing of the resin itself. High temperatures and humid conditions cause the most rapid ageing.

UFFI dust is another source of formaldehyde. As UFFI ages it may become brittle and decompose, thus releasing dust through cracks and other gaps in the inner leaf of the external wall, into the living quarters of the building. Therefore voids in the inner leaf of the external wall should be filled. Any work involving removal or disturbance of the UFFI should only be carried out by experts.

## Common questions

### *What are VOCs and where do they come from?*

Volatile organic compounds are defined as organic chemicals with boiling points between 50–100 °C and 240–260 °C (according to the WHO, although some definitions give one range of 50–270 °C). They are released from many substances used indoors such as consumer products (polishes, toiletries), building fabrics and furnishings (painted surfaces, carpets, sealant) and from humans (metabolites). Many VOCs have a characteristic smell.

### *What is a safe level of VOCs in the home?*

Although there is no evidence to suggest that levels of VOCs in homes in the UK are likely to be a risk to health, it is advisable to keep sources of VOCs to a minimum. If there is a source of VOCs in the home, for example as a result of laying a new carpet or painting and decorating, levels will be higher. These high levels should not persist for long and will not affect the majority of people. However, those with allergies or respiratory diseases may sometimes be affected. In rare cases there may be an unidentified source of VOCs in the home and unusual odours may be noticed. In this situation it may be helpful to measure VOC levels, but in most instances measurement is not necessary.

### *What are the health effects of VOCs?*

At VOC levels typically found in UK homes, there is no evidence to suggest that there is a risk to health. At higher levels those with allergies or breathing disorders may experience worsening of their symptoms. Healthy people may notice unusual smells or general discomfort. High levels of exposure, which could occur for example during painting for extended periods of time, could result in irritation to the eyes or nose, headaches, dizziness or nausea. Some VOCs can cause cancer, but this is extremely unlikely at the levels of exposure found in the home.

### *There is an unusual odour in my home, what should I do?*

Firstly, combustion appliances such as central heating boilers should be checked for fumes, as leakage from these is potentially lethal. Once these have been ruled out, check for possible drain blockages. If the odour occurs at certain times of the day, keep track of temperatures and humidity if possible, and record activities. If the source of the odour can be located in one particular room, remove objects, such as furniture, one by one to see if there is an improvement. If the odour cannot be eliminated it may be necessary to consult experts who may undertake an air quality assessment.

### *My neighbour has recently installed a damp-proof course, and I am being affected by the smell, what should I do?*

If the odour does not decrease with good ventilation and time, the neighbour should ask the installer to check that the installation has been done properly. It may be necessary to contact the local environmental health officer for advice. Further assistance may be required from experts who could perform an air quality assessment.

### *Are air cleaners effective at removing gases and smells from the home?*

Air cleaners are classified according to the method by which they remove pollutants from the air. For removal of dust particles, mechanical and electrostatic filtration are used. Gas and vapour molecules cannot be removed effectively by either method, so adsorption* onto carbon is one commonly used method.

Air cleaners are effective in removing some indoor pollutants but the size and the duration of the beneficial effect is unclear. Air cleaners alone cannot ensure adequate air quality, particularly where significant sources are present and ventilation is poor.

* physical condensation of a gas or vapour on an activated solid substrate

*I think that I am susceptible to VOCs, how can I make my home VOC-free?*

There are many sources of VOCs, so it is not possible to make any home entirely VOC-free. Levels can be kept to a minimum by careful selection of products, for example water-based paints, used in the home and ensuring adequate ventilation. If any renovation or refurbishment work is carried out, it is wise not to live in the house concerned whilst it is being done. If in doubt about the levels of VOCs in the home, it is advisable to get advice from an expert and perhaps have the levels checked.

*What might the effects on my pets be?*

There are no data regarding the health effects of domestic animals and exposure to VOCs at levels in the home. However, animals are likely to benefit from the same precautions that are described above for humans.

## Bibliography

BRE (1996) *Indoor Air Quality in Homes: Part 2 The Building Research Establishment Indoor Environment Study*, London, Crown Construction Ltd

ECA (1997) *Total Volatile Organic Compounds (TVOC) in Indoor Air Quality Investigations* (Report No. 19 EUR 17675 EN), Luxembourg, Commission of the European Communities

IEH (1996) *IEH Assessment on Indoor Air Quality in the Home* (Assessment A2), Leicester, Institute for Environment and Health

## Further information/contacts

BRE, Bucknalls Lane, Garston, Watford, WD2 7JR

The Chartered Institute of Environmental Health, Chadwick Court, 15 Hatfields, London, SE1 8DJ

# Annex 1

## Measurement methods for VOCs and formaldehyde

There are several approaches to measuring the concentrations of formaldehyde and VOCs in an indoor environment and the selection of the most appropriate method depends upon the purpose of the investigation and the resources available. The two main approaches are pumped sampling and diffusive sampling methods.

Pumped sampling will require a technician to visit the property and undertake air sampling during the visit. Normally sampling times of 30 minutes to 1 hour are used. For the investigation of complaints of poor air quality, windows and doors are kept closed for 12 hours prior to the sampling and for the duration of sampling. The sampling is likely to determine peak or worst-case concentrations. It may be appropriate for specific activities that could cause the problem to be in operation, e.g. use of office machinery during the sampling period. The benefits of active sampling include the opportunity for a technician to observe and place samplers near possible sources and it may be useful to collect and undertake laboratory investigations of products that may be a source of VOCs.

Diffusive samplers are small and convenient tubes and badges that can be sent to the occupant of the building under investigation. The occupants can expose the samplers themselves according to instructions provided. After a period of days to weeks, depending on the type of sampler, the occupant closes the sampler and sends it back to the laboratory for analysis. The diffusive sampler provides a measure of the mean concentration over periods of days or weeks in the building under conditions of normal occupation. They do not provide information on the changes in concentration that may occur around the mean value. The investigation can usually be undertaken at a lower cost because it does not involve a site visit by a trained investigator. The responsibility is with the building occupant to ensure correct exposure of the sampler and that no untoward interference occurs by, for example, blowing tobacco smoke directly onto the sampler. The result of the diffusive sampler measurement can be compared with published results for other buildings if the same sampling and analytical techniques are applied. It may be necessary for a subsequent visit by a trained investigator to identify the source of any unusual amounts of VOCs found by the diffusive sampling method.

Other techniques may be used for specific purposes and these may not be suitable for the investigation of the concentration range of chemicals that can cause odour and irritation. Commercially available indicator tubes developed specifically for workplace monitoring can be used to screen for high concentrations, but a response is not normally expected in non-industrial environments. Continuous monitors, such as those based on infra-red absorption, also lack the sensitivity and specificity to identify levels of VOCs in indoor air. Specific monitors such as portable flame ionisation detectors can be appropriate if specific sources such as landfill gas are suspected, but the apparatus must be intrinsically safe.

Appropriate methods for measurement of VOCs and formaldehyde in indoor air are described in draft international standards. The measurement of formaldehyde relies on the reaction of formaldehyde with 2,4-dinitrophenylhydrazine to form a stable complex that can be determined by high performance liquid chromatography. Active and diffusive monitors are commercially available, but their proper handling and analysis requires a specialist laboratory. VOCs are determined by trapping on a polymeric adsorbent contained in a steel or glass tube. The tubes can be used with a pump for active sampling, or rely on diffusion to collect the VOCs from the air. After exposure the tubes are analysed by thermal desorption / gas chromatography with detection by flame ionisation and mass spectrometry.

As well as the selection of appropriate methods, there is a need to draw up a sampling strategy to identify the number and frequency of measurements required. This may need to consider a range of factors including the size of the building and individual rooms, possible sources, specific activities, nature of the building use, the type of complaint or concern.

Further advice on air sampling methods and appropriate strategies can be obtained from BRE.

# Annex 2

## Current controls on VOCs

- British Standard (BS) regulates UFFI quality, limits the product's use and limits ingress of formaldehyde vapour into buildings (BS: 5617, 5618 (1985)).

- A BS Institution standard (BS 5669 part I (1989), BS 1142 (1989)) regulates the formaldehyde content, together with test methods that must be used to assess formaldehyde levels in particle boards and fibreboards.

- Under the Control of Pesticides Regulations (COPR) 1986, any home treated with liquid wood preservatives must not be re-entered within 48 hours of the treatment, unless it can be proved by the approval holder that air levels of the pesticide formulation are below an acceptable level.

- There are several voluntary labelling schemes for products containing VOCs. The majority of these schemes are run by trade associations and a smaller number by government, independent bodies or commercial companies. Sometimes schemes are a result of co-operation between two or more organisations. For example, a trade association, US Carpet and Rug Institute operates a scheme based on research and co-operation between the US EPA and the US trade associations concerned with the manufacture of carpets. This scheme regulates a number of properties, including VOC emissions from carpets, and requires that products are regularly tested by independent laboratories to receive accreditation.



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# Annex 3 ECA list of volatile organic compounds

| Chemical compound | CAS No. | Boiling point (°C) |
|---|---|---|
| **Aromatic hydrocarbons** | | |
| Benzene | 71–43–2 | 80.1 |
| Toluene | 108–88–3 | 111 |
| Ethylbenzene | 100–41–4 | 136.2 |
| *m/p*-Xylene | 108–38–3/106–42–3 | 139.1/138.3 |
| *o*-Xylene | 95–47–6 | 144 |
| n-propylbenzene | 103–65–1 | 159 |
| 1,2,4-Trimethylbenzene | 95–63–6 | 169.4 |
| 1,3,5-Trimethylbenzene | 108–67–8 | 165 |
| 2-Ethyltoluene | 611–14–3 | 165.2 |
| Styrene | 100–42–5 | 145.2 |
| Naphthalene | 91–20–3 | 218 |
| 4-Phenylcyclohexene | 31017–40–0 | 251–253* |
| **Aliphatic hydrocarbons (n=C6 to n=C16)** | | |
| n-Hexane | 110–54–3 | 69 |
| n-Heptane | 142–82–5 | 98.4 |
| n-Octane | 111–65–9 | 125.7 |
| n-Nonane | 111–84–2 | 150.8 |
| n-Decane | 124–18–5 | 174.1 |
| n-Undecane | 1120–21–4 | 196 |
| n-Dodecane | 112–40–3 | 216.3 |
| n-Tridecane | 629–50–5 | 235.4 |
| n-Tetradecane | 64036–86–3 | 253.7 |
| n-Pentadecane | 629–62–9 | 270.6 |
| n-Hexadecane | 544–76–3 | 287 |
| 2-Methylpentane | 107–83–5 | 60.3 |
| 3-Methylpentane | 96–14–0 | 63.3 |
| 1-Octene | 111–66–0 | 121.3 |
| 1-Decene | 872–05–9 | 170.5 |
| **Cycloalkanes** | | |
| Methylcyclopentane | 96–37–7 | 71.8 |
| Cyclohexane | 100–82–7 | 81 |
| Methylcyclohexane | 108–87–2 | 101 |
| **Terpenes** | | |
| 3-Carene | 13466–78–9 | 167 |
| α-Pinene | 80–56–8 | 156 |
| β-Pinene | 181172–67–3 | 164 |
| Limonene | 138–86–3 | 170 |
| **Alcohols** | | |
| 2-Propanol | 67–63–0 | 82.4 |
| 1-Butanol | 71–36–3 | 118 |
| 2-Ethyl-1-hexanol | 104–76–7 | 182 |
| **Glycols/glycolethers** | | |
| 2-Methoxyethanol | 109–86–4 | 124–125 |
| 2-Ethoxyethanol | 110–80–5 | 135 |
| 2-Butoxyethanol | 111–76–2 | 171 |
| 1-Methoxy-2-propanol | 107–98–2 | 118 |
| 2-Butoxyethyoxyethanol | 112–34–5 | 231 |
| **Aldehydes** | | |
| Butanal | 123–72–8 | 76 |
| Pentanal | 110–62–3 | 103 |
| Hexanal | 66–25–1 | 129 |
| Nonanal | 124–19–6 | 190–192 |
| Benzaldehyde | 100–52–7 | 179 |
| **Ketones** | | |
| Methylethylketone | 78–93–3 | 80 |
| Methylisobutylketone | 108–10–1 | 116.8 |
| Cyclohexanone | 108–94–1 | 155.6 |
| Acetophenone | 98–86–2 | 202 |
| **Halocarbons** | | |
| Trichloroethene | 79–01–6 | 87 |
| Tetrachloroethene | 127–18–4 | 121 |
| 1,1,1-Trichloroethane | 71–55–6 | 74.1 |
| 1,4-Dichlorobenzene | 106–46–7 | 173 |
| **Acids** | | |
| Hexanoic acid | 142–62–1 | 202–203 |
| **Esters** | | |
| Ethylacetate | 141–78–6 | 77 |
| Butylacetate | 123–86–4 | 126.5 |
| Isopropylacetate | 108–21–4 | 85 |
| 2-Ethoxyethylacetate | 111–15–9 | 156.4 |
| TXIB (Texanolisobutyrate) | 6846–50–0 | – |
| **Other** | | |
| 2-Pentylfuran (2-tert-butylfuran) | 3777–69–3 | >120 |
| Tetrahydrofuran (THF) | 109–99–9 | 67 |

From ECA (1997)

CAS, Chemical Abstracts Service; * Value for 1-Phenylcyclohexene