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Residues of Benzene in Chemical Products

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Benzene is known to be toxic to human health and the environment (RSC 1989; Howard 1990). It is also a human carcinogen (Margolick and Vogt 1992). The use of benzene in the formulation of chemical products, especially consumer products, is therefore avoided. Benzene residues may, however, be present in various chemical products, because it is a very important starting material for chemical manufacture. Traces of benzene may also be expected in chemical products in which petroleum fractions are used as ingredients. Organic solvent containing chemical products in this respect may be of concern because they may contain petroleum fractions like benzine, white spirit, mixture of aromatic hydrocarbons, etc. Furthermore, in any industry, contamination of non-benzene products with benzene may occur, if benzene-containig materials are used for some other purposes in that industry. Thus, besides tobacco smoke and gasoline combustion, which are the major sources of benzene exposure to the general population (Graedel 1978; IARC 1982), the general population may also be exposed to benzene vapours during the professional- or non-professional use of chemical products. The knowledge of benzene content in various chemical products, may therefore be useful for the estimation of exposure of benzene to the general population. In the present study, 133 differnt chemical products, both consumer products and products for professional use, have been investigated for the content of benzene. The products chosen for the study, painters' materials, lubricants, abrasives and glues, all are well known to contain a variety of organic solvents.

MATERIALS AND METHODS

Chemical products investigated for the content of benzene are described in Table 1. The products were obtained from the Danish importers/manufacturer of these products or from the Danish market.

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Table 1. Chemical products investigated for benzene content.

Chemical Product	Number of Products
Painters' materials (paints, paint-bases, primers, paint strippers, paint diluents and cleaners)	82
Lubricants and abrasives	25
Model and hobby glues	26

Gas chromatography (GC) was used for the analysis of benzene. The chemical products without any non-volatile matrix were analysed by direct injection of the sample into a chromatograph. Benzene analysis of the products containing a non-volatile matrix was performed by employing a headspace GC technique. A CP-Sil-5CB capillary column was used for the analysis of benzene in the products that contained non-polar petroleum fractions. Benzene analysis in the other products was performed by the use of a Supelcowax 10 capillary column. The GC was performed using a Hewlett Packard (HP) gas chromatograph HP 5890A coupled to a HP 3393A integrator, and a HP 19395A headspace autosampler, for the headspace analysis. The experimental conditions for GC analysis were as follows:

GC column: Supelcowax 10, 60 m x 0.32 mm, 0.25 μm film.
Temperature programme: 8 min at 50°C, 2°C/min to 100°C, thereafter 10°C/min to 220°C.
Injector: Split injector at 250°C, injection vol. 1 μL.
Detector: Flame ionisation detector at 250°C.
Carrier gas: N_2, column flow 1 mL/min, split 1:30.
Makeup gas: N_2, 30 mL/min.

or

GC column: CP-Sil-5CB, 50 m x 0.32 mm, 1.2 μm film.
Temperature programme: 3 min at 40°C and thereafter 5°C/min to 250°C.
All other conditions were the same as described for Supelcowax column.

For the headspace GC analysis, approximately 50 mg of a homogeneous sample was accurately weighed in a 10-mL headspace glass vial. The vial was capped immediately

after weighing with a PTFE-coated silicone septum. The glass vials and the septa were preheated at 150°C for 16-18 h before use. The headspace analysis of the samples was then performed by GC as described above. The headspace autosampler was used under the following conditions: oil bath at 80°C; loop temperature 130°C; equilibration time 3 h; loop vol. 1 mL; and carrier gas N_2, 25 mL/min.

All the products were analysed by GC-mass spectrometry (MS) to confirm the identification of benzene. Conditions for GC-MS analysis were essentially the same as described before (Rastogi 1991, 1992). Benzene content in the products was determined by an external standard method employing headspace GC (Rastogi 1991, 1992).

RESULTS AND DISCUSSION

Benzene in the investigated products was identified on the basis of its retention time by GC as well as on the basis of its mass spectrum. In general, the Supelcowax 10 column was found to be suitable for the analysis of benzene residues in the products which contained polar solvents, and a non-polar CP-Sil-5CB column was good for the products which contained non-polar solvents. The detection limit of the benzene, in the present investgation was 2 ppm.

As described in Table 2, 64 of the investigated products, i.e., 48% of the products, were found to contain 4 - 748 ppm benzene. Benzene was present in 42 - 50% of all type of products investigated.

Products that contained benzene also contained one of

Table 2. Benzene content in the investigated products.

Product	Number of benzene containing products	% of total investigated products	Benzene content (ppm)
Painters' materials	41	50	4 - 390
Lubricants and abrasives	12	48	15 - 410
Model and hobby glues	11	42	27 - 748

the following solvents (concentration in the products of >1%) as ingredients: toluene, xylenes, mixture of aromatic hydrocarbons C_9 - C_{12}, white spirit, and benzine (a mixture of alkanes C_5 - C_7, cyclohexane, methylcyclohexane and isooctane). The results of the present study thus indicate that benzene residues may be expected in the chemical products in which above mentioned solvents are used as ingredients. As the products analysed in the present study were both for professional and non-professional use, an unwanted exposure of the general population with benzene may occur.

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