

12.4.5 Mercury in compact fluorescent lamps (energy-saving light bulbs) and fluorescent tubes

Compact fluorescent lamps (energy-saving lamps) and fluorescent tubes contain small amounts of mercury, which is required for the illumination process in these lighting products. Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment [15] restricts the quantity of mercury that can be used in lamps in the European Union and requires manufacturers to reduce the levels further. Since January 2012, manufacturers have had to mark the mercury content on the packaging of the lamps.

No mercury is emitted from lamps when they are used as intended. However, when energy-saving lamps or fluorescent tubes are replaced or otherwise handled (when being collected for recycling, for example), there is a risk that they might be damaged. If they break, mercury vapours can be released [16].

Measurements conducted by the UBA on new energy-saving lamps on the market have shown that there are no significant concentrations of mercury following lamp breakages when the broken lamp is disposed of completely and the room immediately aired [17]. It can therefore be assumed that mercury does not pose any health risks.

To minimise the risk of mercury exposure, any new lamps purchased should contain as little mercury as possible. Faulty lamps should not be replaced while still hot because hot lamps give off more mercury vapours when broken than cold ones do. Spent lamps must be disposed of at appropriate collection centres (e.g. recycling centres or retailers), not along with household waste, and breakage should be kept to a minimum.

12.4.6 Dust

Up to 50% of the dust that occurs indoors originates in the outdoor air. Other sources of dust in the rooms used include dust attached to room users' shoes and clothes, sedimented particles being raised or disturbed mechanically (e.g. when vacuum cleaners are used or paper is handled) and work equipment. The concentration and composition of indoor dust varies significantly depending on how the room in question is used [18]. For instance, large deposits of dust in rooms that are otherwise cleaned normally or situations in which large quantities of paper are handled, e.g. archives and during copy processes are an indication that the dust levels in the ambient air will be high.

Bar a few exceptions, dusts do not have harmful or unwanted effects provided the concentration in the indoor air is roughly equivalent to that in the outdoor air. It should, however, be borne in mind that semi-volatile organic compounds (SVOCs), biocides, polycyclic aromatic hydrocarbons, and plasticisers, among other things, may accumulate on the dust particles thereby potentially causing unwanted, irritating or harmful effects [19].

The potential health hazards posed by exposure to dust are assessed on the basis of dust fractions, which depend on the particle size. The fractions commonly used in the field of occupational safety and health are "respirable dust" and "alveolar

dust". These are not identical to the fractions commonly used in the area of environmental protection, PM₁₀ (particulate matter) and PM_{2.5}, which provide a first approximation of the total of all airborne dust particles with a diameter of up to 10 and up to 2.5 µm respectively [20].

The recommended practice for assessing dust exposure in indoor workplaces is to use the PM_{2.5} and PM₁₀ fractions defined for environmental protection purposes since the indoor concentration levels are mainly influenced by the outdoor air, for which assessment values are available. The Committee on Indoor Guide Values suggests that, where there are no combustion processes (e.g. tobacco smoke), the 25 µg/m³ daily value defined by the WHO be used as the assessment value for the PM_{2.5} fraction [18].

The working group does not propose an assessment value for the PM₁₀ fraction, however, citing the fact that the concentration levels for this fraction are considerably higher indoors than they are outdoors. This means that the main sources of this particle fraction are to be found outdoors. A conclusive assessment is not possible because there are no further details available on the composition of this fraction [18].

In general, it should be ensured that the PM₁₀ fraction concentration does not exceed the EU dust limit for tropospheric air of 50 µg/m³ [6].

The Committee on Indoor Guide Values recommends that rooms be sufficiently ventilated in order to reduce indoor dust exposure. In addition, every effort should be made to find and minimise known sources of particulate matter [18].

Fibrous dust

The effects of fibrous dust are such that it requires a separate assessment. The main indoor sources are textile fibres, e.g. interior textiles or clothing, and natural and man-made mineral fibres, e.g. in thermal insulating materials. Asbestos fibres are no longer of relevance indoors, provided the Asbestos Directive's [21] requirements concerning assessment of the urgency of clean-up measures are complied with as well as the criteria set out in TRGS 519 "Hazardous Substances" [22] regarding the protection of employees and third parties in connection with clean-up measures.

Fibrous dust is considered harmful to health if it can be inhaled and is "bio-persistent". According to a WHO definition, fibres can be inhaled if they have a length of > 5 µm, a diameter of < 3 µm and a length-to-diameter ratio of > 3 : 1 (these are known as "WHO fibres"). The level of bio-persistence depends on the fibre material. Since 1998, man-made mineral fibres (MMMFs), as used in mineral-wool insulating materials, have only been allowed to be sold if their bio-solubility half-life (breakdown by endogenous substances) is less than 40 days.

Mineral-wool insulating materials can cause fibrous dust exposure if they come into direct contact with the ambient air (as in open applications such as sound-absorbing panels in louvre systems) and, in particular, if they are subjected to vibrations or

accelerated air velocity. Only in these cases are measurements potentially useful.

The irritant effect of MMMFs, which is occasionally the subject of debate, is linked to fibres larger than the WHO variety and only occurs if mineral-wool insulating materials have not been installed properly or the cladding has become damaged over time and there are visible fibrous dust deposits. According to Walker et al. [23], there are no health-related grounds for removing old MMMF insulating materials that have been properly installed.

Asbestos fibre dust poses much more of a hazard. If it is suspected that asbestos fibres have been released in the building in question, further investigation must be carried out using the customary procedures, as described at length in [24] for example. If necessary, a refurbishment plan must be drawn up in line with the requirements of the Asbestos Directive [21].

Tobacco smoke in indoor workplaces

Tobacco smoke in indoor air is classified as carcinogenic for humans. By law, employees are entitled to a smoke-free workplace. Section 5 (1) of the Arbeitsstättenverordnung (Ordinance on Workplaces) [25] states:

“Employers must take the measures necessary to ensure effective workplace protection for non-smoking employees against the health hazards of tobacco smoke.”

There are various ways of complying with the legal requirement to protect non-smokers. The most effective is to impose a universal ban on smoking throughout the building concerned. Once such a ban is in place, there is no longer any need to include tobacco smoke when investigating sources of air pollution.

The German statutory accident insurance institutions published a report in 2011 on the topic of tobacco smoke pollution in workplaces, including an in-depth review of exposure situations in indoor workplaces [26].

12.4.7 Phthalates

Phthalates continue to be manufactured on a large scale. Around 1 million tonnes are currently produced every year in Western Europe, roughly 90% of which is used for plasticising in polyvinyl chloride (PVC) production [27]. Indoor applications include plastic floor coverings, additives including additives in building materials such as concrete, coatings or sealants and in condensers, wallpapers and textiles. As phthalates can be used as solubilising agents, they can also be found in paints, varnishes, adhesives, cosmetics and personal care products.

Unusually high levels of butanol and/or 2-ethylhexanol detected in the VOC analysis can be an indication of increased phthalate concentrations since they can be released from dibutyl phthalate (DBP) and di(2-ethylhexyl)phthalate (DEHP) plasticisers by means of hydrolysis.

Usually DEHP dominates indoors and has been found at concentrations around the low $\mu\text{g}/\text{m}^3$ mark in the air in homes

examined in a number of studies [27]. The total phthalate content usually detected in house dust can be up to 1,000 mg/kg though this increasingly includes longer-chain phthalate substitutes, e.g. diisononyl phthalate, in addition to the main component, DEHP [28].

Due to their hormonal properties and toxicity to reproduction, phthalate plasticisers in dust in nurseries can be a particular problem. The average phthalate level in such dust is more than three times higher than that of dust in homes [29]. The main sources are furnishings made of soft PVC – for instance, PVC floors, vinyl wallpaper, gym mats, plastic tablecloths or imitation leather upholstery. By contrast, there has long been a ban, for example, on the use of phthalates in children’s toys, which used to be common.

The UBA has recommended nurseries not to buy soft PVC products so as to reduce phthalate levels. Instead, nurseries and parents should opt for products that do not contain any of the plasticisers listed as being “of high concern” [30]. Retailers and distributors must provide consumers with the relevant information on request. Parents and nurseries should take advantage of this right. The UBA has drawn up a template letter for contacting retailers to find out more [31].

12.4.8 Insecticides

Although insecticides, i.e. products for insect pest control, are primarily used in agriculture and forestry, they are also used extensively indoors for the following purposes:

- to preserve wood and protect fabric (e.g. permethrin in wool carpets);
- to provide mosquito protection (electric vaporisers and sprays);
- to protect plants against pests;
- to treat parasitic skin diseases in humans and animals; and
- to eliminate pests (e.g. cockroaches, silverfish) by means of decontamination.

The following categories of substance currently play a role in indoor applications:

- Pyrethroids

Pyrethroids serve as active ingredients in more than half of the insecticides used indoors. They go by various names, including permethrin, cypermethrin, cyfluthrin, deltamethrin, allethrin and tetramethrin. Recently, there has been much debate about their effect on human beings. The target organ for pyrethroids is the nervous system – both in insects and in warm-blooded animals. Incorrect handling can cause acute poisoning in humans but there is also some debate as to the possibility of the substances penetrating the skin. The chronic neurotoxic potential is deemed to be low. Unlike the natural product pyrethrum, pyrethroids are extremely persistent by virtue of their absorption capacity, low vapour pressure and