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Abstract. A new type of emissions barrier was used in premises with indoor air complaints due to emissions from the buildings in question. The emissions comprised chlorophenols/chloroanisoles and polycyclic aromatic hydrocarbons (PAH) from treated wood, and volatile organic compounds (VOC), mainly 2-ethylhexanol, from PVC flooring and the glue used to paste the flooring onto a concrete slab. Attaching the barrier at the surfaces from where the emissions were spread (floor, walls, ceiling) resulted in a fresh and odour-free indoor air. We conclude that using an emissions barrier in buildings made unhealthy by moisture is an efficient way of restoring a pleasant and healthy indoor air.

1. Introduction

Building moisture typically results in spread of chemical and biological emissions into the indoor air leading to illnesses and symptoms such as asthma, skin and eye irritation, fatigue etc. Drying is a necessary first step in remediation because it will stop further moisture-driven reactions with the building materials as well as (continued) mould growth. However, drying is not enough to secure a clean indoor air, since the numerous chemicals that have been formed from water - or moisture – acting on the materials will still remain in the building construction and over time inevitably be emitted into the indoor air. The emissions may be e.g. VOC from paints, glue, insulation materials, chipboards, microorganisms, impregnation and plasticizer chemicals, or toxins from microorganisms such as mould. In the present study we applied a new type of emissions barrier [1,2] developed at Lund University Sweden to stop such emissions thereby improving the indoor air quality (IAQ) in buildings with IAQ complaints.

2. Methods

This study comprised three buildings with IAQ complaints due to emissions from the building construction. In short, the surfaces from where the emissions were spread (floor, ceiling, walls) were covered with a flexible emissions barrier to prevent them from reaching the indoor air. In the specific barrier used, the cTrap, an adsorption layer functions together with a hydrophilic polymer sheet making the adsorption virtually irreversible [1, 2]. The flexible cTrap cloth was attached at the surfaces using an adhesive tape and/or a staple gun. The indoor air concentrations of the emissions were measured both before and after the cTrap installations.

The cTrap cloth is a laminate of two active layers plus an outer and inner protective nonwoven layer. The cloth must be applied so that the inner layer faces the surface from which the emissions are spread. Above the inner layer is an adsorption layer, then a hydrophilic polymer layer and finally the outer layer. Emissions that diffuse from the building structure will be adsorbed in the adsorption layer. VOC which in the first turn may escape through the adsorbent will impinge on the polymer layer, bounce back to the adsorbent, and there have a longer time for adsorption. Research has shown that this adsorbent/polymer combination leads to a very effective adsorption even for small and polar VOC [1, 2]. VOC approaching the cTrap cloth from the other side ("from the outside") are stopped by the polymer layer and will thus not reach the adsorbent and load it.

Moisture passes through the cloth by diffusion almost without any resistance at all ($Z = 200$ s/m). There can therefore never be any accumulation of moisture inside the cTrap cloth with the risk of mold growth or moisture damage to the substrate, something that is important not least for sensitive (eg q-marked) wooden buildings. On the other hand, a cTrap installation on a damp concrete floor must be supplemented with a moisture barrier (eg a polyethene foil). The choice of measure is normally made in consultation with professional damage investigators, where RH, choice of surface layer etc. are taken into account. Particles are stopped because the cTrap is airtight.

3. Results

A townhouse was studied where the tenants suffered from itching all over the body when staying at home, symptoms which disappeared when outside the building. A PVC flooring had been glued onto a concrete slab which had become moist through diffusion of water from the ground. The air concentration of 2-ethylhexanol, a compound which is ubiquitous in small concentrations in indoor air but found in increased concentrations e.g. following hydrolysis of glue and/or phthalates of PVC floorings, was 63 µg/m3 (directional measurement). The cTrap was attached onto the existing flooring, and the itchiness disappeared. 3 months after cTrap had been installed the air concentration was 1.5 µg /m3 (Table 1), a value which persisted in a follow-up study 6 years after the installation - and the residents still reported no symptoms.

A building where a creosote-based tar layer had been attached onto the concrete slab as a moisture barrier was studied. The air concentrations of polycyclic aromatic hydrocarbons (PAH) were 1726 ng/m3 air. There was a disturbing smell inside the building which persisted even after the tar had been removed. Then, the cTrap cloth was installed on about 75 percent of the wall surface. The smell disappeared and the PAH air concentration decreased to 139 ng/m3, thus corresponding to a reduction of 92% (Table 1).

We studied the living-room and a bedroom of a wooden summer house built in 1964 with a disturbing "summer cottage smell" indoors which was attributed to chloroanisoles. The building had previously been treated with chlorophenol-containing preservatives which were widely used in the 1960-70s; at moist conditions chlorophenols may be biomethylated to form chloroanisoles having an intense, characteristic mould-like odour. The ceiling, walls and floor in the bedroom (as well as the doorway between the bedroom and the living room), but not in the living-room. were covered with the cTrap cloth. Subsequently, air sampling for chlorophenols/chloroanisoles was carried out simultaneously in both rooms. Tetrachlorophenol, trichloroanisole, and pentachloroanisole were detected in the air of the living-room, but only tetrachlorophenol was found in the bedroom, and in an air concentration 93% lower than in the living room (Table 1). Also, the mouldy odour disappeared in the bedroom following the cTrap installation.

Results are summarized in Table 1.

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Table 1. Results of cTrap installations.

Emissions (ug/m^3)	Without cTrap	With cTrap
Tetrachlorophenol	0.14	0.01
Chloroanisoles	0.013	n.d.
PAH	1.726	0.139
2-ethylhexanol	63	1.5

4. Discussion
Staying in a moist building can cause health problems [3] e.g. in the respiratory tract due to moisture-driven emissions which are spread from the building construction into the indoor air. This study shows that such emissions can be effectively stopped by using an emissions barrier. Laboratory findings [2], as well as several years of experiences in buildings (data not shown), have revealed that by such measure the symptoms and/or unpleasant odour decrease or disappear completely. If any visible mould is observed it should first be removed by chemical or mechanical methods before applying the barrier to ascertain that no remaining mould products, or traces of the aggressive chemicals that might have been used, can escape into the indoor air. The specific device used in the current project, the cTrap (surface emissions trap), is air tight while at the same time allowing moisture to pass through with almost no resistance at all, and will thus not affect the moisture balance of the building [1, 2]. After the device has been applied on a floor a surface layer, e.g. a laminate, parquet, or plastic flooring etc, is installed on top of the cTrap cloth. When attached on walls or ceiling the cloth is usually covered with a gypsum board which is then painted or decorated with a wall-paper. We conclude that use of an emissions barrier represents an effective, economic, and eco-friendly way of restoring a healthy indoor air in buildings affected by moisture.

5. Conclusions
In summary, use of an emissions barrier may provide an efficient, economic, quick, and environment-friendly way of ensuring a healthy indoor air.

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References

[1] Markowicz P and Larsson L 2012 The surface emissions trap: A new approach in indoor air purification *J Microbiol Methods* 91 pp 290-294

[2] Markowicz P and Larsson L 2015 Improving the indoor air quality by using a surface emissions trap *Atmos Environ* 106 pp 376-381

[3] Mendell M, Mirer A, Cheung K, Tong M and Douwes J 2011 Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence *Environ Health Perspect* 119:6 pp 748-756