“Awareness raising on environmentally sound use of interior materials and construction”
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4. CHEMICALS AND SUBSTANCES IN ARTICLES - REACH REGULATION AND MAIN RISKS

4.1 Background of old construction products

4.1.1 Asbestos

From some construction products can separate harmful emissions of substances to working air and through possible exposure to workers. One example is asbestos. Historically, asbestos is a term used to describe several types of naturally-occurring fibrous minerals in rock stone. There are several types of asbestos fibers, all of which are lightweight, fire-resistant and not easily destroyed by natural processes. Because of these characteristics, asbestos was regularly used in construction and thermal insulation until about 1979. However, when broken or crushed, asbestos becomes airborne dust and may stay in the air for long periods of time. I short time exposure asbestos can cause asthma like lung diseases. As inhaled for very long times like working in 20 years’ exposure, asbestos can influence asbestosis and cancer. Because there is no known safe level of exposure, all asbestos exposure should be avoided. For this reason, the short-fibered asbestos are forbidden. Asbestos products can, however, still be purchased (roofing sealant and tile cement, for example) but they are not, however, in the prevalent use. Asbestos questions come very important particularly when removing asbestos from insulations in the old buildings.

4.1.2 Floor construction materials and recycling

Some materials can leach hazardous chemicals to inhaled air. There are rather little knowledge, on how the harmful substances, especially from the older construction materials, can to be leached into the indoor air. The floor construction can, e.g. be harmful in humidity, clueing and surface materials conditions with different chemicals like formaldehyde, phthalates and organic compounds. For that reason, the modern recycling of construction materials (Fig. X1) is under many requirements.

Important options in recycling of old materials, e.g. carpets and window frames must be done before their separation. It is, especially, important to make a coordinated and accepted selection system for the separation of different kinds of materials from each other like, e.g.:

- Options for carpet recycling because there is seldom enough knowledge on their exact trade name, substance, clue or other chemical quality and content
• Options for old window frames and doors with unknown substances, paint elements, mastic cement contents, other chemicals etc. must have qualified recycling options.

Because the chemicals are un-known and their leaching mechanism is difficult to identify, it is important, in handling of the recycled construction wastes, to use suitable and valid protection tools against the possible harmful emissions.

Fig. X1. Both old and new construction products of floor materials and other materials from buildings must be managed through the officially standardized and regulated recycling systems in EU.

For the recycling system, when constructing a new building or renovating or totally demolishing the older one, there must be planned a suitable recycling system as a part of the national system. In recycling, it is important to take into account the following checking phases: inventory and occurrence of specific substances, documentation of building materials and included chemical content and occurrence of “phase-out substances” Occurrence of “phase-out substances”.

To inventory, in the environmental planning tool of a house belong affects like ozone-depleting compounds, PCB, asbestos, lead, mercury and bromated flame retardants classified as “phase-out” substances. To building materials documentation books should belong a logbook in which all construction materials, included chemicals, are documented. Documentation should also contain emissions from the smaller sewage
systems like minimum levels of the separated organic matters, phosphorous and nitrogen. To tap water sampling can also have been used chemicals against microbiological effects.

4.1.3 Forbidden substances in construction materials

Resistivity of wood surfaces during the long transportations and requirements in fire and insulation resistance against humidity are, f.e., reasons why there have been added different chemicals to materials. Many hazardous substances like short chain chlorinated hydrocarbons, tributhyltin and bromated fire retardants have earlier been used in protection purposes of materials but are now totally been forbidden. To the chemical markets come all the time, however, new chemicals. This kind of chemicals are, f.e., nonyl and octylphenols. These substances belong to the hazardous, hormonally affecting, endocrine disrupting chemicals.

Concerning materials in exploitation for buildings, there are certain followed-up hazardous chemical classes in EU. To these chemical classes belong substances like:

- Brominated fire retardants
- Cd metal and Cd in other substances
- Cr metal and Cr in other substances
- As containing substances
- Perflourooctansulphonates (PFOS) and the other perflouronated compounds
- Hg and compounds with it
- Phthalates
- PCB

PCB (Polychlorinated Biphenyls) is an older class of toxic plasticizer and capacitor oils, and is nowadays totally forbidden. Also some older window frame isolation mastic patty can contain PCB. PCB chemicals are hazardous on nerve systems. Environmentally PCBs are toxic substances which are soluble in animal fat and they can accumulate for many years to the environment without degrading. All possible waste which can be contaminated by PCB, must be handled carefully in the separate national problem waste plants.

Brominated fire retardants (BFRs) are a class of “the in use-forbidden” chemicals. BFR chemical can be toxic to the “in water living” organisms. For people, having long exposure with these chemicals, BFRs can cause liver hazards. BFRs can also have hormonally disrupting effects on human nerve system. In official buildings, the have been possible to use BFRs in many interior materials. To these belong materials like:

- Textiles which are used in furniture, e.g., in transit halls
- Textiles of the transportation vehicles, in aviation, trains etc.
- Plastic covers of the electric and electronic equipments (EEE)
- Plastic based insulation with EPS and XPS rubber polymers

The recycling of above materials must be controlled carefully in separation of the materials components and substances. Many directives and laws, like the REACH chemical regulation, been taken into use in EU. The purpose of these is to improve both humans and environment safety against chemicals.

4.1.4 Migration path theories for chemicals leaching from materials surfaces
The theory behind the leaching of chemicals from materials alters, due to the different surface structures, and it can’t be quite easily be explained in details. It is, however, well-known that the leaching of emissions can proceeds on a molecular level by the different mechanisms. Schematic presentation of mechanisms are in Fig. X2. The main mechanisms for leaching and migration of chemicals from material surfaces are as follows:

• Evaporation
• Dissolving
• Diffusion
• Mixture of above mentioned: evaporation + dissolving + diffusion

The problem is that, the particulate matters, dust and emissions on the molecular level around us in the indoor air are not visible. However, we live and stay the greatest part of our life, about 12 ours per day in indoor. The tests in exposure, e.g. are difficult to carry out, they take a lot of time and are also expensive. This makes the bases of the evaluation of the interior materials difficult for the workers, users and consumers. In green housing, the role of the use of the many kinds of instructions, labeling, SDSs, directives, regulated laws and the other information & education becomes very important. It is also good to follow the humidity and the other housing indicators of the building, periodically. Evaluation of VOC emissions from building products in solid flooring materials have been followed-up, however, already since 1997 by different working groups in EU. The measurements of VOC emissions take a long time and need a special tight testing chamber.

![Chemicals leaching mechanisms and different types of molecular emissions from a material surface.](image)

**Fig. X.** Chemicals leaching mechanisms and different types of molecular emissions from a material surface.

The mentioned migration factors (Fig. X2 above) are also such which should be taken into account already in the very early product development and processing phase. Based on modern and green product development, it is not acceptable any more to choose for indoor materials such a content which contains very volatile or easily dissolving or reactive substances. In polymerized materials, it is also possible to influence on the structure of the indoor materials, so that the material has smaller tendency to diffusion typed migration into the inhaled air. The present sustainable objective, to have natural materials, which are 100 % recyclable in indoor buildings, is also very good.

### 4.2 Guidance for chemicals use in new green products and materials
4.2.1 Criteria for green products

Outside the questions concerning the harmfulness of chemicals, the present criteria takes into account also factors like the amount of producing energy and costs to produce green products for interior materials. To criteria to produce, exploit and use the new indoor materials belong then factors like:

- There are used, e.g., the new dry polishing of floors without wax. This is environmental-friendly and lowers the life-cycle costs
- The carpets are 100 % recyclable and bio-decomposed
- Linoleum carpets (trade name: e.g. Forbo) are 100 % from natural materials floor coverings and can be recycled
- Textile carpets (trade names: e.g. Interface FLOR and Heuga 580) are the part in the "Mission Zero" program, where the whole life-cycle releases of a carpet are aimed to reach the zero release level at 2020
- Textile carpets are produced by using renewable energy

4.2.2 Standard requirements

The specific details of the currently marketed indoor materials in buildings are found by the trade names of the products in Google. In Finland, there is also developed a material emission based M I and M II classification system for construction materials in buildings. Details from the Finnish classification system are presented in web page for interior materials in classes M I and II U(link: http://www.rts.fi/english.htm), see Table Y1.

Table Y1. Finnish building materials classification system for materials in volatile chemicals, odors and emissions.

<table>
<thead>
<tr>
<th>Examined material qualities</th>
<th>Class M I [mg/m2h]</th>
<th>Class M II [mg/m2h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission total volatile organic compounds (TVOC). Minimum of 70% of compounds identified.</td>
<td>&lt; 0.2</td>
<td>&lt; 0.4</td>
</tr>
<tr>
<td>Emission of formaldehyde (HCOH)</td>
<td>&lt; 0.05</td>
<td>&lt; 0.125</td>
</tr>
<tr>
<td>Emission of ammonia (NH3)</td>
<td>&lt; 0.03</td>
<td>&lt; 0.06</td>
</tr>
<tr>
<td>Emission of carcinogens belonging to cat. 1 of the IARC monographs 1987*</td>
<td>&lt; 0.005</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Odor: dissatisfaction with odor shall be below 15 %</td>
<td>Is not odor</td>
<td>Is not significant odor</td>
</tr>
</tbody>
</table>

The Finnish indoor air requirements are in Table Y2.
Table Y2. Indoor air requirements in Finland.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Unit</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium and amins</td>
<td>µg/m³</td>
<td>20</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Fiber/cm³</td>
<td>0</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>µg/m³</td>
<td>50</td>
</tr>
<tr>
<td>Carbonmonoxide</td>
<td>mg/m³</td>
<td>8</td>
</tr>
<tr>
<td>Particulate matter, PM10</td>
<td>µg/m³</td>
<td>50</td>
</tr>
<tr>
<td>Radon</td>
<td>Bq/m³</td>
<td>200 year aver.</td>
</tr>
<tr>
<td>Styren</td>
<td>µg/m³</td>
<td>1</td>
</tr>
</tbody>
</table>
| One prevailing or many un-identified...    | HTP (Impurities in work place air known to be hazardous) | One: 1/10 from work place value, many: $\sum C/HTP > 0.1$

4.3 REACH regulation

4.3.1 Abbreviation of REACH
REACH is the new EU chemicals legislation which deals with the Registration, Evaluation, Authorisation and Restriction of Chemicals. REACH covers chemical substances as such, in preparations or in articles (in products) where chemicals are intended to be released. The regulation replaces numerous EU laws and is complementary to other environmental and safety legislation. It also substitutes a large part in national chemicals regulation.

4.3.2 Objectives
REACH regulation’s aims are:
- To increase responsibility of industry in producing safe chemicals to the EU market
- To ensure a high level of protection from exposure to chemicals in order to safeguard human health and the environment
- To provide improved risk management
- To stimulate innovation and competitiveness of the EU chemicals industry
- To search out by increased research projects the new substitute chemicals

4.3.3 Registration of chemicals
All substances produced by industry in an amount of 1 ton per year, must be registered in ECHA. ECHA is the European Chemicals Agency in Helsinki in Finland. However, there are also exemptions from certain parts of the legislation, f.g., chemicals in food and medicine are covered by other EU laws. If the chemicals are not registered, the following principles are exploited:
- ‘No Registration – No Market’ meaning that non-registered substances and non-registered uses can become illegal
- The connection of CPD Directive to REACH Regulation must be valid
- Current construction product regulation will require that a declaration of performance (DoP) must be supplied with each construction product, placed on the market, including emissions data information for hazardous substances, produced by the product during its all use phase.

4.3.4 The supply chain
Virtually everyone in the supply chain, dealing with chemical substances, will have certain obligations. Manufacturers or importers of chemical substances or mixtures of chemical substances, located in the EU are, the responsible parts of the supply chain of the chemicals. Downstream users processing chemicals, formulating preparations (mixtures) for the end-use or using formulated products as part of their business belong also under the REACH supply chain requirements.

4.3.5 Definition of an article
REACH Regulation don’t use the word product but instead of that the word article is used. Definition of an article (product) has thus only been given in REACH. In REACH, article means a product which has a certain outer form and surface. This form then, in many cases, determines, in the usage, article’s exploitation more predominantly than the chemical content of the product itself. However, the chemicals in products can determine the health and the other indoor and environmental characteristics like the accumulated amount of substances in the article to the inhaled air on the long-life scale. For that reason, the substance and mixture content in indoor materials is very important. The new REACH regulation requires that all information concerning also the articles on their substances and the declaration of performance, must be provided together with the Safety Data Sheets (SDSs). Chemical substance in export of chemicals means base chemicals, special chemicals, metals, and also natural materials, if they are chemically modified. In this connection REACH have effects on exported mixtures of chemicals and substances in the markets. REACH concern then substances like cleaning products and paints. These products are also used in buildings.

4.3.6 Forbidden chemical content in products
ECHA updates the list of banned chemicals in EU. If the usage level of the very toxic chemical (SVHC, Substances of Very High Concern) has been used in a product (article) over than 0,1 Volume-%, the product belongs under the requirements, regulated in REACH (REACH, article 33). ECHA has gathered the list from forbidden chemicals. In the list updated in Dec., 2010, there were mentioned the following chemicals:
- Benzyl butyl phthalate (BBP)
- Bis(2-ethylhexyl)phthalate (DEHP)
- Dibutyl phthalate (DBP)
- Diisobutyl phthalate
- Hexabromocyclododecane (HBCDD)
- Trichloroethylene
- benzo[a]pyrene
- benzene
List above shows especially how some phthalates and BFRs are now forbidden. New SVHC list is planned to be updated by ECHA all the time now after the risk evaluations with chemical producers have been finalized. In practice, the amount of the forbidden chemicals in products, based on the candidate list of the possibly hazardous chemicals, is much more bigger than presented now in this review.

4.3.7 Safety data sheets of substances of very high concern (SVHC)
REACH concerns import of the chemicals when the importer of the product must give also consuming information like SDS and analysis info on possible side effects. The user should also have, as much as possible, knowledge on health and on occupationally and environmentally hazardous chemicals effects. Important is to ask for in usage the other substitute products with the less harmful effects in the future. Article 31 of REACH sets out the requirements for safety data sheets (SDSs). Article 33 requires that suppliers of articles containing Substances of Very High Concern (SVHCs, See candidate list on web pages of ECHA and in 4.3.6 above) must provide the receiver with sufficient information to allow safe use of an article.

The new regulation views construction products both as preparations and articles. All content information for hazardous substances of construction products must be made obtainable for workers and users. The new Documents of Processing (DoPs) must be supplied in paper form if requested. If not, they may be supplied in paper or electronic form, or published on a website as long as the information is kept available for a minimum of ten years. The European Federation for Construction Chemicals (EFCC) does welcome many of the provisions and additional requirements on substances in the new REACH regulation. In spite of REACH, there also exist many nationally regulated requirements for emissions in construction products.

4.4 Future Nordic steps for planning the green and safe building materials
4.4.1 Total tools to plan environmentally healthy buildings
In Sweden there have been planned total environmental rating tool for sustainable buildings. The planning and development process of this kind of a tool must nationally takes into account aspects like:

• Earlier national and international experiences
• Usefulness in a long time-perspective
• A large number of factors concerning different types of buildings
• Life-cycle thinking
• Development in a broad cooperation
• Compatible with other societal goals
• Most significant environmental aspects of buildings
• Easy to use (means the tool), scientifically sound and comprehensive

To the planning of a total environmental tool for building evaluation, belongs as important part the indoor environment with materials & chemicals. Environmental assessment of a building is a complicated task, and a simplified rating tool will always involve compromises. A single environmental rating of a building (including interior) can never be more than a very rough estimate of the environmental performance. In tool structure can be focused also special requirements like the extent of the building and inner-house materials-related environmental & health problems when the materials
substance and chemicals possible releasing assessment is always included to the environmentally sustainable and green planning tool.

4.4.2 Information systems on materials safety for the future

In addition to REACH law and many national regulations and directives against hazardous chemicals, many countries have begin to build up information systems on how to separate, collect and re-use safely the huge amounts of the older construction materials. The Norwegian Climate and Pollution Control Agency have, e.g. published a summary of information on building products that can contain the banned or in some way regulated chemicals for users and importers. The documents highlight that, it is the importer’s responsibility, based on REACH law, to ensure the new products sold, don’t contain the banned substances, and that the consumer can, by the controlled country systems, to recycle the old construction and demolition wastes. Important is also the disposal of these wastes, based on the regulated ways so that the waste disposal is described as required.

On the national level, there should exist a totally planned and safe system for re-use of the building materials. This system should consist in collaboration developed assessment tools for the sustainability of the buildings environmental planning for the future. Materials should be separated based on the hazardous chemicals content. The all kind of re-use should take into account health and environmental effects. In this sustainable exploitation system which, in sparing the materials and natural resources, is very important, all supply chain, manufactures, importers, workers, users and consumers should get enough objective information.

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