# From product flow data to organic substance emissions to the environment – the case of PVC flooring

Filippa Fuhrman[1], Sverker Molander[1], Johan Tivander[1], Louise Sörme[2], Hanna Brolinsson[2], Tomas Holmgren[3], Peter Haglund[3], Patrik L. Andersson[3]

[1]Division of Environmental Systems Analysis, Chalmers University of Technology, Gothenburg, Sweden
[2]Statistics Sweden, Regions and Environment Department, Stockholm, Sweden
[3]Department of Chemistry, Umeå University, Umeå, Sweden,

E-mail contact: filippa.fuhrman@chalmers.se

## 1. Introduction

PVC (polyvinyl chloride) is a frequently used flooring material. In this application the thermoplastic material contains a number of additives that provide key properties such as flexibility, heat stability and colour. The use of PVC has attracted interest from environmental researchers due to the emissions of the plasticisers DEHP and DINP [1].

A conceptual model covering the economy wide emissions of chemicals based on flow statistics of products and diffusive mass-flow equations dependent on product use, has been developed [2, 3, 4]. In order to apply the model a case study on the product PVC flooring and its possible total emission in Sweden of the organic substance Di-iso-nonyl-phosphate (DINP), during one year, was conducted aiming at:

a) identifying possible methods, at Statistics Sweden, for extracting and combining data from the national product flow, in order to populate the emission model for the production, installation, and use phases,
b) identifying barriers for extraction and combination of product flow data, for PVC flooring
c) filling in the data gaps in the emission model with data from other branch sources, to be able to make a quantification of the DINP emissions from PVC flooring in Sweden.

## 2. Methods

In order to estimate emissions from all PVC flooring in Sweden for one year a material flow model (MFA) for calculating the total stock (as area) of flooring was combined with a diffusive mass-transfer model. The combined model relies on data for:

- the accumulated PVC flooring area in Sweden (in $m^2$)
- the lifetime of the flooring (in years)
- the thickness of the surface layer of the product (in mm)
- concentration of organic substances in the material (in kg/kg or $kg/m^3$)
- prediction of substance and material specific parameters for partitioning (unitless), diffusion ($m^2/s$) and convection mass transfer (m/s)
- environmental conditions during usage as air movement (turbulence, windspeed etc.), material and air temperature (K)

The diffusive mass transfer model [2] was developed based on [4] to quantify the emissions from a specified material, containing specified organic substances, in a specified environment. The model generates emitted mass of chemical substance per area and time unit, which is the final output.
To populate the model and make quantifications of emissions on a national level from the use phase, data was gathered from databases of Statistics Sweden, The Swedish Flooring Trade Association and a Swedish PVC flooring producer.

At Statistics Sweden, existing databases, published statistics and available methods were used for identifying and illustrating the possible methods and barriers for extraction and combination of product flow data [5].

Calculation of the total accumulated stock of customs category codes (*the Combined Nomenclature, CN*) 3918 10 10 and 3918 10 90 (that include PVC floorings) was made using equation (1).

Accumulated stock = Life time x (Imports – Exports + Domestic production) (1)

## 3. Results and discussion

### 3.1. Net flows and accumulated stocks of PVC flooring

The estimated accumulated stock of material included in CN 3918 10 10 and CN 3918 10 90 was in year 2006 308 million $m^2$. This figure has a significant uncertainty but is a reasonable estimate. PVC flooring belongs to the aggregated CN code of 3918 10 – *floor- wall- or roof coating materials of polymers of vinylchloride*. It is not possible to separate the PVC flooring from the wall and roof coatings when calculating the accumulated stock of CN 3918 10 10 and CN 3918 10 90, however it gives a maximum value to compare with values given by other sources.

The life time for the PVC flooring used in the above equation was originally derived from an interview with a Swedish PVC flooring producer [5].

PVC flooring manufacturing industry is included in the branch of *manufacturing of plastic building products*, PVC flooring commerce industry is included in the branch of *commerce trade with timber and other materials* and PVC flooring installation industry is included in the branch of *floor and wall coating* [5]; all of these branches are too aggregated groups of industries to yield any, in this case, useful substratum data on either material composition assessment or accumulated PVC flooring area for the different life-cycle phases. It is not possible to split up the branches and extract only PVC flooring related companies since economic and trade information from individual companies is confidential. There is no data at Statistics Sweden about purchasing of PVC flooring in the household sector.

### 3.2. Emissions of the plasticizers DINP and DEHP from Swedish PVC flooring

Calculated emissions of DINP for the year of 2006 from SCB data on accumulated stock are 2248 kg per year i.e. three times higher than the emissions calculated from sales data from The Swedish Flooring Trade Association; 689 kg per year [2]. This can be explained by the fact that SCB data contains data on wall and roof coating as well, there are however also reasons to assume the branch association data are somewhat underestimated since the association only covers about 65 % of the Swedish market [5].

## 4. Conclusions

This case study shows that the data categories and the methods needed for estimating the accumulated product area exist at Statistics Sweden, in principle, but the data is sometimes too aggregated or too protected to make the calculations on a detailed product category level, as in this case for PVC flooring. Using product flow data from the least aggregated level of the Combined Nomenclature, for PVC flooring, generates calculated emissions three times higher than the emissions calculated from the more specific product flow data from The Swedish Flooring Trade Association.

For the occasional product it is possible to interview producers to receive information needed for the emission model, but doing the same for all products in Sweden would be very resource demanding.

The PVC flooring case study boils down to the facing of a trade off when it comes to national emission assessment of several product categories; using data from Statistics Sweden generates emissions within a reasonable period of time, but with aggregated and in this case, too high values – using branch product flow data generates more accurate emission values but is not a plausible option due to the steep increase in resource demands.

## 5. References

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