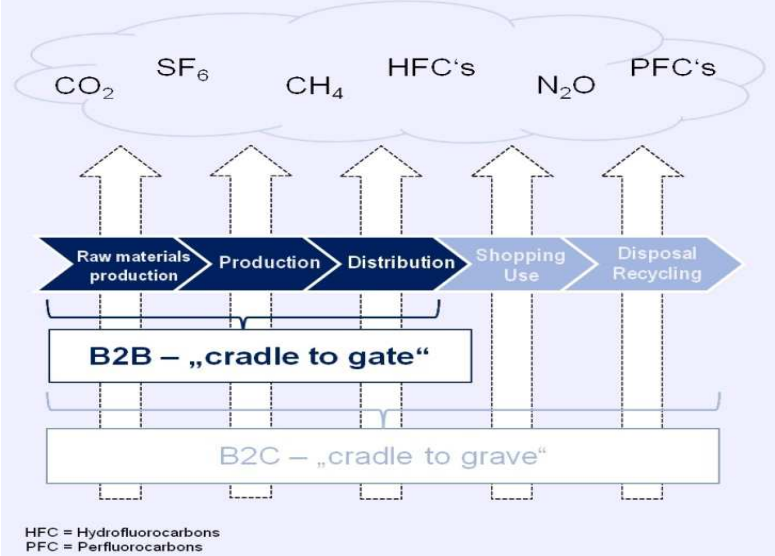
Product Carbon Footprint of Pigments & Fillers

What is a Product Carbon Footprint?

The Product Carbon Footprint (PCF) totals the greenhouse gas emissions of a product in CO_2-equivalents during its life cycle. Starting from the exploitation (mining) of raw materials, through the production process and use phase to recycling and finally disposal.

There are several approaches to PCF calculation in the supply chain (B2B). The most accurate is to confine it to a plant's boundaries (gate to gate). A more useful one for the downstream supply chain is to measure from cradle (raw materials) to gate.

Regarding consumer products (B2C), additional aspects such as shopping, use phase and recycling of the product have to be taken into account. Thus, a cradle to grave approach should be applied.



Scheme: PCF calculation by B2B and B2C approach

PCFs in the pigment and filler industry

More than half of the elements of the periodic table are utilised by the pigment and filler industry for the manufacture of its products. This results in a large variety of raw materials, being of mineral or petrochemical origin.

Pigments and fillers can be found in nearly all products of our everyday life and the companies of our downstream supply chain are equally numerous.

Thus, we decided to determine CF values of our products from cradle (raw materials) to gate and to provide our downstream users with these PCF values.

Our route: cradle to gate determination and grouping

Our aim was to obtain valid results, which meet scientific standards, in a cost-effective and practical manner.
For the determination of CF values of relevant products within the plant's boundaries, our companies have calculated the green house gas emissions (in CO_2-equivalents) for the various production processes used.
The Eurocolour secretariat was provided with these PCF values, anonymously, which were then aggregated in various pigment categories and analysed by the secretariat. The analysis showed that the reported PCF values could be further grouped in three classes: inorganic pigments and fillers, metal and effect pigments and organic pigments.

Approach and results

During the calculations the availability of PCF values of the starting materials turned out to be problematic. As far as PCF values were accessible from databases, these were used. If the PCF value of a raw material was not available, the PCF value of a substance with a comparable production process was employed (read across).
Formulation ingredients with concentrations below 3% were discarded. If the sum of the minor ingredients added up to 10% or more of the formulation, one minor ingredient was chosen as representative for the calculation.
The margin of error is about ±30 to ± 50%, which is mainly due to inaccuracies in the PCF values for the raw materials.

The groups of pigments and their PCF values

Inorganic pigments and fillers

6 ± 50% (kg CO_{2e}/kg product)

Metal and effect pigments

8 ± 30% (kg CO_{2e}/kg product)

Organic pigments

26 ± 50% (kg CO_{2e}/kg product)

CO_{2e} = CO_2-equivalents

Evaluation of pigment PCFs

Pigments and fillers are always used in mixtures to achieve **effects** and adjust **colours**. When evaluating the published PCF values, differences in **colour strength** and **concentration in use** of pigments and fillers need to be taken into account.

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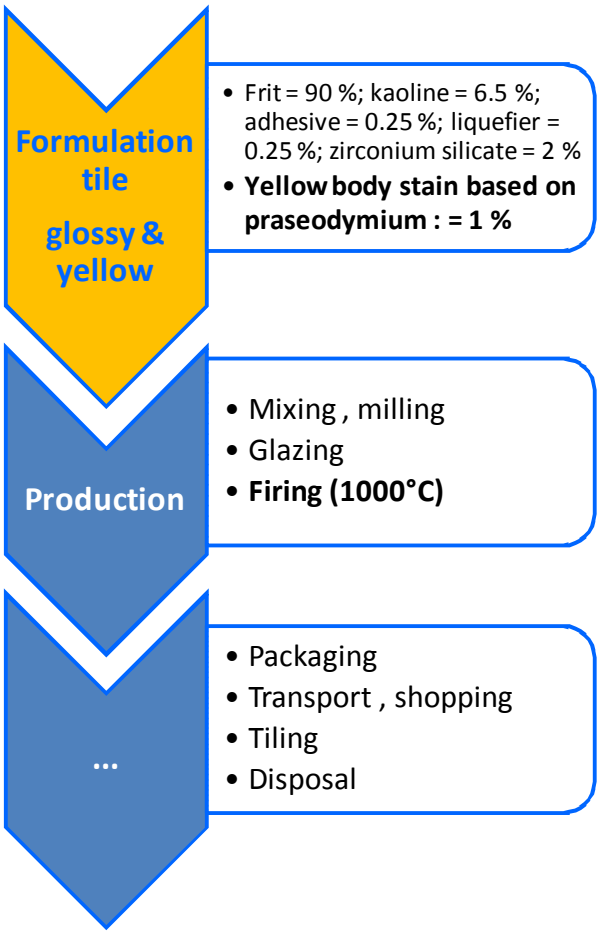
The pigmentation depends on the application (e. g. masterbatches, paint, printing ink) and usually ranges between 0.1% and 20%.
The contribution of pigments and fillers, to the CF value of a product, is almost negligible in comparison with the CF value for the product's life cycle (cradle to grave), because the **use phase** has the **most significant impact** on the CF of many products.

Formulation examples, processing steps and product life cycle

Wall and floor tiles



Automotive paint

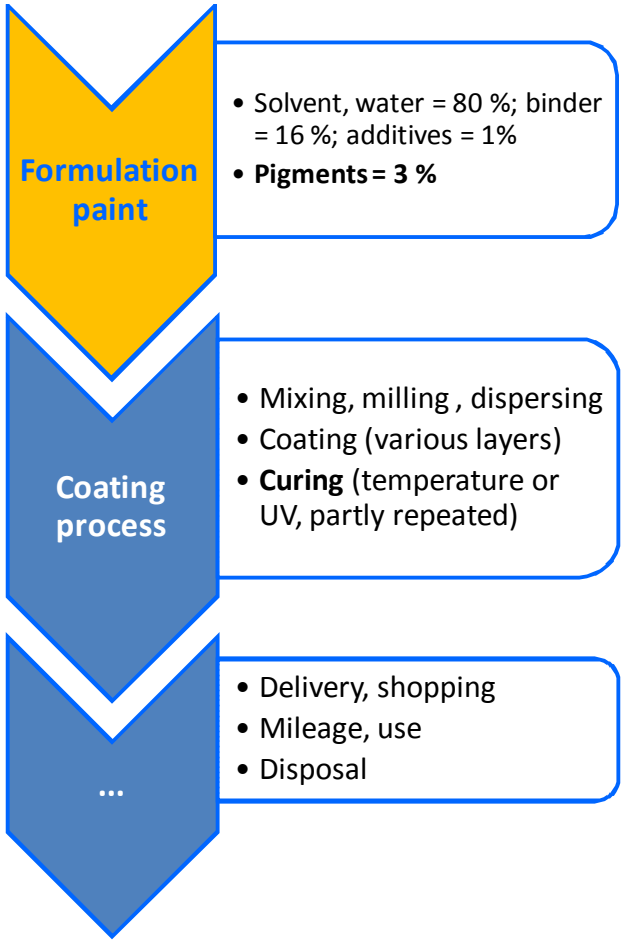


Fig.: "Kuggen" in Gothenburg with tile facade
Source: Wingårdh Arkitektkontor

Fig.: Metallic automotive coating
Source: Carl Schlenk AG

More sample applications for the handling of PCFs

Plastic garden chair

The differences in colour strength of pigments are adjusted, in practice, by using larger or smaller quantities.
Organic pigments usually have higher PCF values, but they exhibit greater colour strength, too.
Thus, realistic pigment loadings can give rise to identical PCFs for final products, such as plastic garden chairs, even though the PCFs of the pigments used were different.

Fig.: Plastic garden chairs
Source: Calligaris S.p.A.

Plastic packaging – Shampoo bottle*

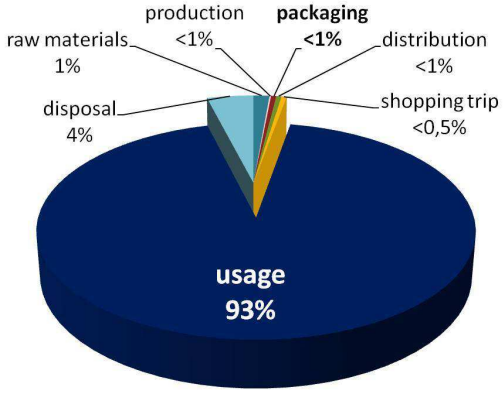


Fig.: Contributions to the PCF of shampoo*

The use phase influences the PCF of consumer products most significantly. The example of a shampoo bottle (plastic packaging) shows clearly, that 93% of the green house gas emissions are due to the usage (hair washing – temperature, duration).
The plastic packaging consists of about 98% of polypropylene or polyethylene, additives (<1%) and a maximum of 2% of pigments.
***Source:** Final report - PCF Project Germany*

Annex: Relevant pigments and fillers

Inorganic pigments and fillers

- Barium sulphate
- Bismuth vanadate
- Carbon blacks
- Chromium oxide
- Iron oxides
- Lithopone
- Rutile (e.g. chromium titanium yellow, nickel titanium yellow, manganese titanium brown)
- Spinel (e.g. cobalt blue, cobalt green, zinc iron brown, black spinel)
- Synthetic amorphous silica
- Titanium dioxides
- Zinc phosphate
- Zinc sulphide

Metal and effect pigments

- Aluminium
- Copper & gold bronze
- Pearlescent pigments

Organic pigments

- Anthraquinone pigments
- Benzimidazolone pigments
- Diketopyrrolopyrrole pigments
- Disazo condensation pigments
- Disazo pigments
- Isoindolinone pigments
- Isoindoline pigments
- Lake pigments
- Monoazo pigments
- Perylene pigments
- Phthalocyanine pigments
- Quinacridone pigments
- Quinophthalone pigments

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