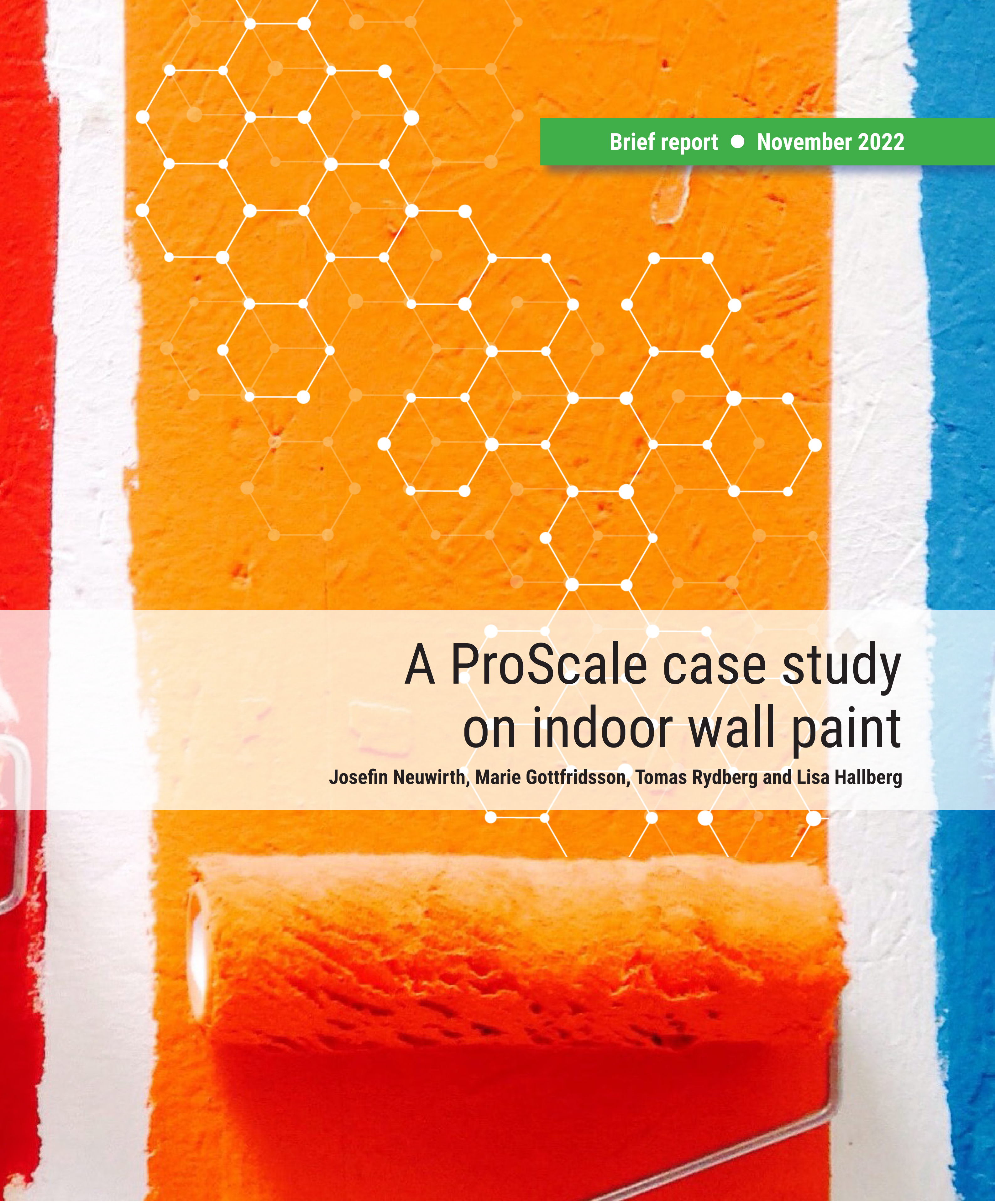

Brief report ● November 2022

A ProScale case study on indoor wall paint

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MISTRA SAFECHEM

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Introduction

ProScale is a method to assess toxicity potentials for products in a life cycle perspective, in its current version covering direct human exposure related toxicity potential. It is designed to be useful on its own or alongside other impact categories in life cycle assessment (LCA). The study reported herein was conducted by examination of the ProScale model in a case study on indoor wall paint. The reason for choosing indoor wall paint was that the EU commission has paint as one of their pilots for Product Environmental Footprint (PEF), and a particular purpose of the case study was to showcase the applicability of ProScale in PEF. The ProScale assessment on indoor wall paint was simplified due to time limitation in scope.

ProScale in PEF pilot study

Goal

The goals of the assessment were:

- To assess the direct human toxicity potential resulting from indoor wall paint by using the ProScale method in life cycle assessment (LCA).
- To identify which processes in the life cycle of the indoor wall paint that have the largest contribution to both inhalation and dermal direct human toxicity potential (dominance analysis).

Scope

The study aimed at investigating the direct human toxicity potential, for both inhalation and dermal, using ProScale for one indoor wood paint.

Type of LCA

The study was an attributional LCA, where the direct human toxicity potential was assessed for the indoor wall paint.

Functional unit

The functional unit was set to protect and decorate 1 m^2 of substrate for 50 years at a specified quality level (PEFCR Paints). The reference flow was 1.409 kg/m^2 specified in the PEFCR for Paints.

The indoor wall average paint formulation specified in the PEFCR for Paints (PEFCR, 2018) was used to assess the systems in ProScale. The paint formulation is specified in Table 1. The “Additive, unspecified”, was approximated with sodium hydroxide.

Table 1. Raw material and weight percentage of the indoor wall paint.

Raw material	Weight percentage (%)
Tap water	31.25
Styrene Acrylate dispersion (SA), 50% in water	21.00
Titanium dioxide[1]	10.90
Ground calcium carbonate, dry	27.15
Kaolin (china clay)	4.25
Propylene glycol	0.40
Additive, unspecified	5.05

Studied system

The studied system is illustrated in Figure 1. The manufacturing of raw materials, the indoor wall paint and the application of the paint were included in the assessment. The application of the paint was assumed to be conducted by a professional. Transport, the use phase and the waste management were not included. Flowcharts illustrating the pre-chains of the raw materials are found in Appendix A.

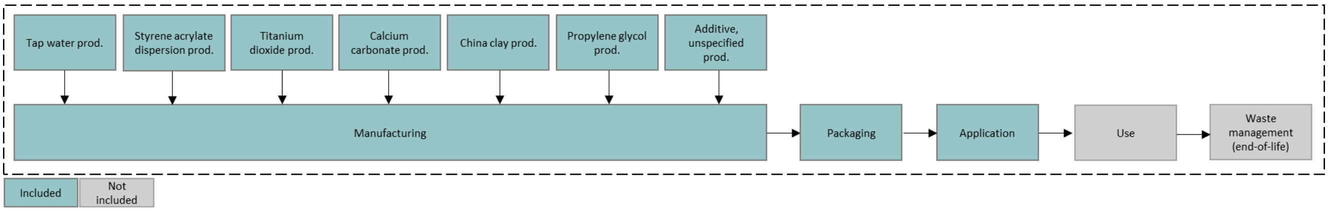

Figure 1. Overview of the studied system. The green boxes are processes included in the assessment, while the grey boxes are processes not included in the assessment.

Limitations

The outcome of the study was influenced by limitations and assumptions made in the assessment. The main limitations of the study are listed below:

- Emissions from the processes to the environment were not included.
- The system boundary was cradle to gate (but also including packaging and application).
- The generation of electricity was not included.

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[1] At the time of carrying out this study, a guidance for classification and labelling of titanium dioxide was available from ECHA and applied herein. Since then, the General Court has annulled the harmonised classification and labelling of titanium dioxide as a carcinogenic substance by inhalation in certain powder forms. These changes in classification and labelling were not considered herein.

- Extraction and processing of fuel used in the processes were not included.
- The transportation of material and fuel were not included.
- The application stage was modeled with the chemicals in the paint formulation as input and not the paint since information (e.g. H-phrase, and OEL) about the paint is lacking.
- Solvent released during application was not included.

Life cycle inventory

The collected data were inputs and outputs of material, chemicals, products and energy (fuel and electricity), which was complemented with ProScale specific data. Generic data for upstream processes were collected from literature, for example Plastic Europe's eco-profiles and the LCA databases GaBi and ecoinvent. The mass- and energy flows were together with ProScale specific data documented in a data collection template specifically developed for ProScale assessments.

The manufacturing was modeled with PROC5 (mixing or blending in batch process). The application was modeled with PROC10 (roller application).

Result and discussion

The cradle-to-gate ProScale results, both inhalation and dermal, for the indoor wall paint are shown in Figure 2. The result shows that the activity contributing mostly to the total ProScale score, for both inhalation and dermal, was the application followed by the raw material production.

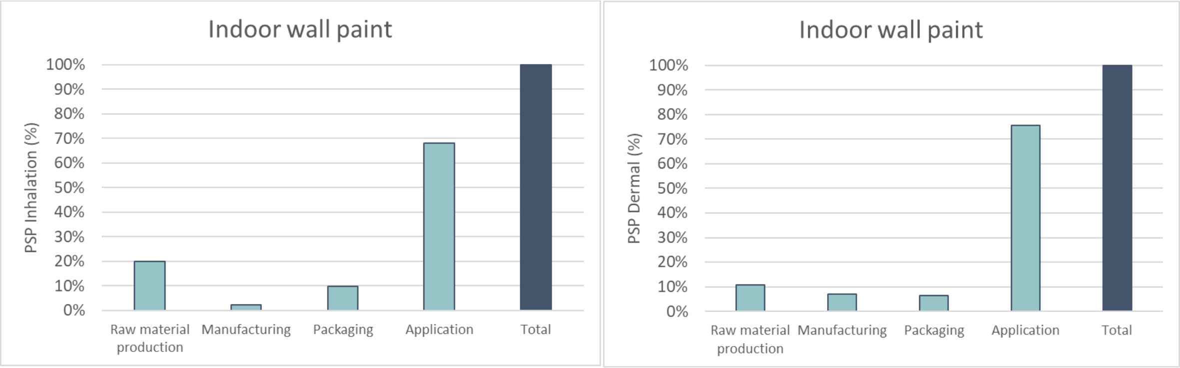

Figure 2. ProScale result for inhalation (left) and dermal (right) for an average indoor wall paint.

The ProScale result, both inhalation and dermal, for the application step of the average indoor wall paint are shown in Figure 3. The result show that titanium dioxide constribute mostly to the total ProScale score for the application step. For dermal, calcium carbonate was also contributing to the total ProScale score for the application step.

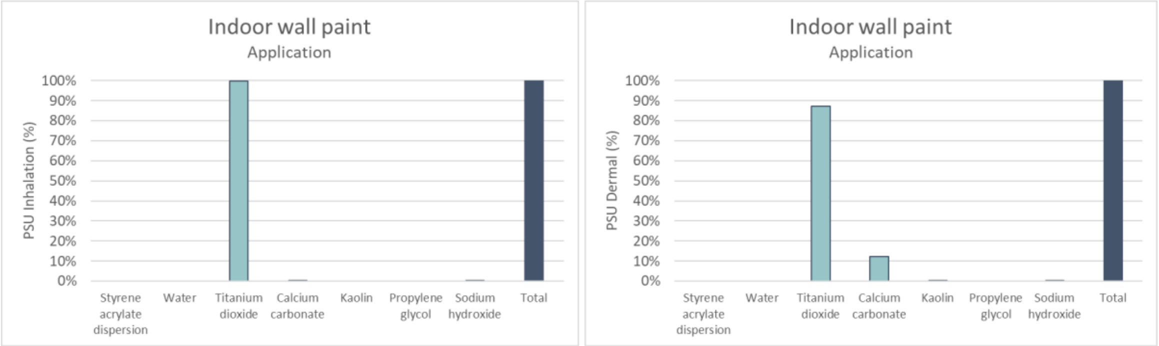

Figure 3. ProScale result for inhalation (left) and dermal (right) of the application step for an average indoor wall paint.

Titanium dioxide was modeled with no Occupational Exposure Limit (OEL) and H351. H351 is included in the next highest ProScale hazard class (D). The H351 classification for titanium dioxide is associated with the substance is in powder form (ECHA, 2021). According to ECHA, the H351 classification is only reasonable to be used if at least 1% of the powder consists of particles with aerodynamic diameter ≤ 10 µm (ECHA, 2021). This means that the result presented in Figures 2, 3 and 5 should be interpreted as a worst-case scenario, since the particle size is unkown in the product studied.

According to ECHA, mixtures containing titanium dioxide do not require H351 classification (ECHA, 2021). But, the mixtures shall be labeled with the EU211 (Warning! Hazardous respirable droplets may be formed when sprayed. Do not breath spray or mist), if they contain at least 1 % titanium dioxide particles with an aerodynamic diameter of ≤ 10 µm (ECHA, 2021). The complementary H-phrase is not included in the ProScale hazard classes, as ProScale currently is limited to H-phrases in the H300-series, and therefore it is not possible to perform the scenario analysis.

In the result shown above, titanium dioxide was modeled as a fluid. Titanium dioxide is dispersed in the paint formula, meaning that titanium dioxide is a solid dispersed in a liquid. It might have been more appropriate to model the application phase by studying the paint as such and not all individual substances within the paint. However, this was not possible since information regarding OEL and H-phrases of the paint were lacking. Therefore, a scenario analysis was conducted on how titanium dioxide was modeled. In the first scenario, the state of titanium dioxide was changed to solid, and the parameter dustiness was set to not dusty. In the second scenario, the state of titanium dioxide was changed to solid, and the parameter dustiness was set to slightly dusty. The ProScale result, both inhalation and dermal, for the scenario analysis of the application phase are shown in Figure 4. The ProScale result, for inhalation, shows that the state of titanium dixode and dustiness have a significant impact on the outcome. In scenario 1, titanium dioxide becomes insignificant, while calcium carbonate contribute most to the ProScale score. For the dermal ProScale score there is no difference between the scenarios.

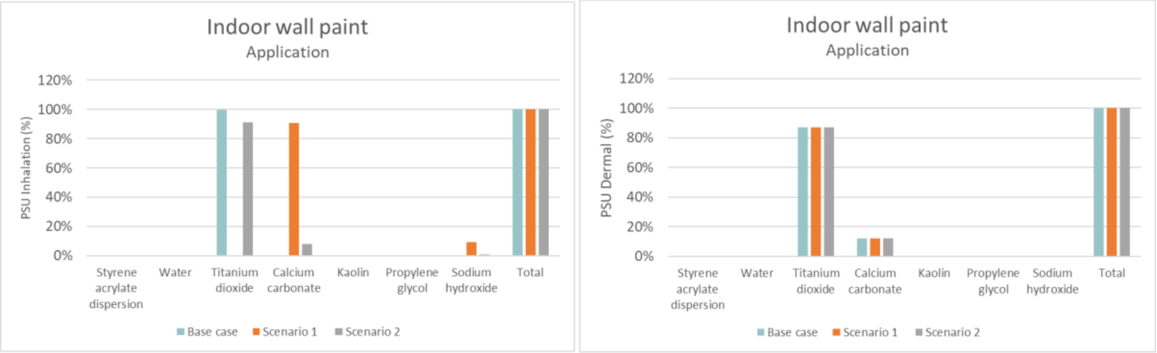

Figure 4. ProScale result for inhalation (left) and dermal (right) of the application step for an average indoor wall paint in three scenarios. In the base case TiO_2 was modeled as a fluid, in scenario 1 TiO_2 was modeled as solid (not dusty) and in scenario 2 TiO_2 was modeled as solid (slightly dusty).

The ProScale result, both inhalation and dermal, for the raw material production step are shown in Figure 5. The result shows that titanium dioxide, styrene acrylate dispersion, and sodium hydroxide contributed mostly to the total, both inhalation and dermal, ProScale score for raw material production.

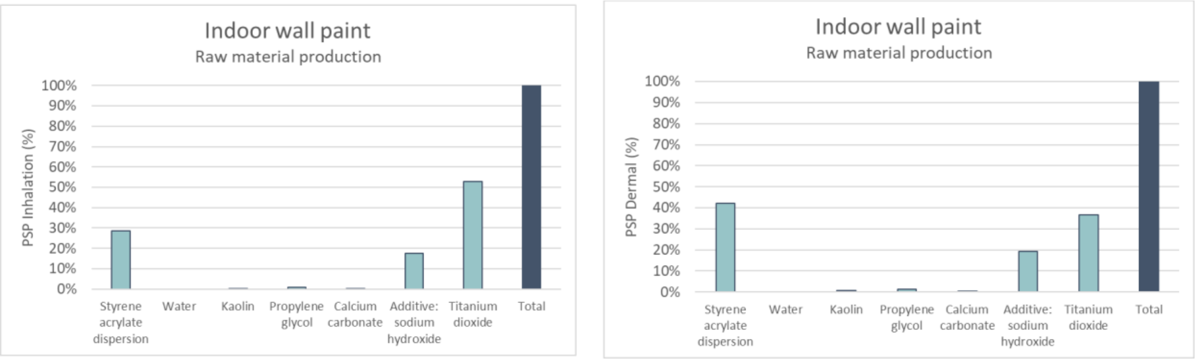

Figure 5. ProScale result for inhalation (left) and dermal (right) of the raw material production for an average indoor wall paint.

Conclusion and outlook

The aim of the study was to showcase the applicability of ProScale in a PEF pilot study. The results in this study show that ProScale can be used in a PEF context. However, more work is needed to include all life cycle stages of the indoor wall paint. This should be the focus in an extended case study on indoor wall paint. Extension of the scope of ProScale to include for example the use phase is planned to be done in the near future.

The ProScale assessment of the indoor wall paint shows that the application contributes most to the ProScale score, both inhalation and dermal. How the application phase is modeled has significant impact on the total ProScale score. At the time of carrying out this study, a guidance for classification and labelling of titanium dioxide was available from ECHA and applied herein. Since then, the General Court has annulled the harmonised classification and labelling of titanium dioxide as a carcinogenic substance by inhalation in certain powder forms. These changes in classification and labelling were not considered herein. It must therefore be emphasised that the results of this case study should only be used to understand, on a conceptual basis, how ProScale can be applied in a PEF study. The results on relative contribution to impact by different components of the paint should not be used as decision support.

References

European Chemical Agency (ECHA). (2021). Guide on the classification and labelling of titanium dioxide. Available at: https://echa.europa.eu/documents/10162/17240/guide_cnl_titanium_dioxide_en.pdf/

Product Environmental Footprint Category Rules (PEFCR) – Decorative Paints. (2018). v 1.0.

Appendix A – flowchart of pre-chains

The pre-chains for the raw materials included are illustrated in Figures A1-A5 below.

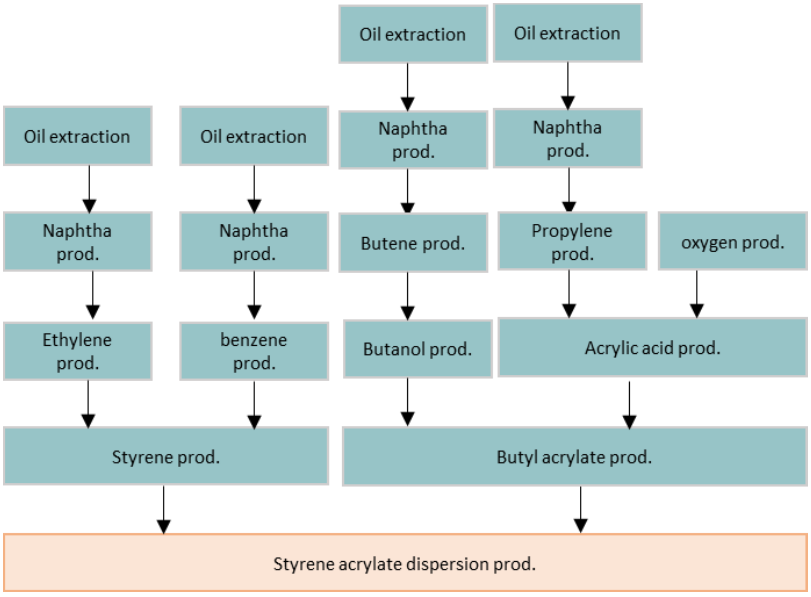

Figure A 1: Processes included for the production of styrene acrylate dispersion.

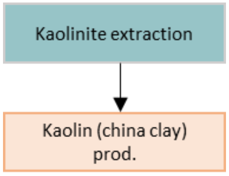

Figure A 2: Processes included for the production of kaolin.

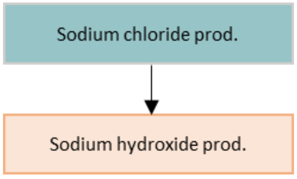

Figure A 3: Processes included for the production of sodium hydroxide.

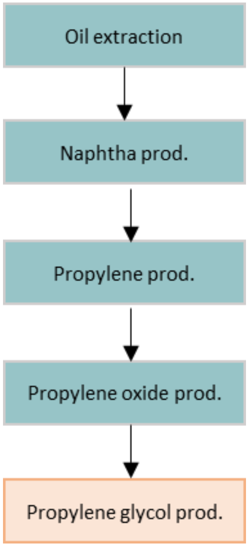

Figure A 4: Processes included for the production of propylene glycol.

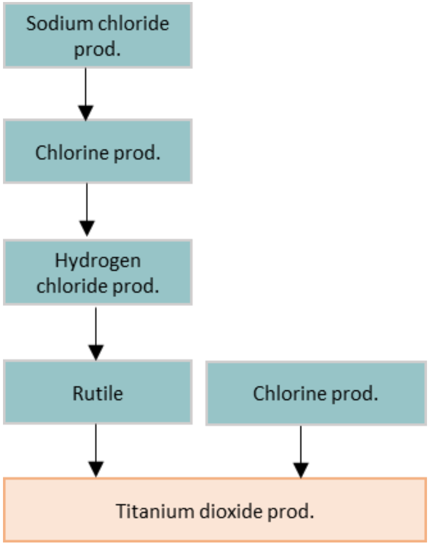

Figure A 5: Processes included for the production of titanium dioxide.

About Mistra SafeChem

Mistra SafeChem is a research programme with the vision
to enable and promote the expansion of a safe, sustainable, and green chemical industry.

The programme is developed with the twelve principles of green chemistry as a fundament.

The research combines the potential of innovative manufacturing processes,
tools for hazard and risk screening, and life cycle assessment
with ambitions and opportunities for the development and growth
of a safe and sustainable chemical industry.

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