Report summary cosmetics

Contents

1 Introduction and method

IVL Swedish Environmental Research Institute and Stockholm University have conducted a study on PFAS in cosmetic products by contract of the Swedish Chemical Agency (KEMI). For references, in-depth questions on methodology and results, and access to the full report, please contact Jenny Ivarsson at KEMI (jenny.ivarsson@kemi.se).

We applied information from several databases or platforms, of which three are European cosmetic databases based on consumer data collected via smartphone applications (apps), i.e. CosmEthics (Finish), Kemiluppen (Danish), ToxFox (German). With these apps, consumers scan cosmetic product barcodes and receive information on ingredients and their potential hazards to make conscious purchase choices or submit new products and product information to the databases.

PFAS searched from the databases were based on an INCI name list based on compilation after a CosIng database search and partly additional INCI names that the cosmetic databases identified as such and shared with us and based on the PFAS definition given in the start. Approximately 170-190 different PFAS (varying among the databases) were searched from the different databases.

The online search function in the CosIng database was used for the identification of PFAS functions as cosmetic ingredients.

Further, several chemical analyses were carried out using three different analytical methods. The analytical procedures were carried out at the Department of Environmental Science, Stockholm University, Sweden. 45 purchased cosmetic products were analysed for their total fluorine (TF) content and a subset of 15 samples was analysed for extractable organic fluorine (EOF) and individual (target) PFAS content.

Based on measured PFAS concentrations, the share of products containing PFAS, sales data from Cosmetics Europe, as well as other parameters and assumptions, the total emission of PFAS from cosmetic products after use to wastewater and solid waste was estimated for the European Economic Area (EEA).

2 Uses / Applications

The estimates of use are based on databases of cosmetic products identifying which PFAS are used, their functions and how common they are in different product groups (Skin Care, Toiletries, Hair Care, Perfumes and Fragrances, Decorative Cosmetics).

2.1 Occurrence of PFAS in different product categories

Based on the most reliable cosmetic databases, Kemiluppen and CosmEthics, the total number of cosmetic products and market share of PFAS-containing products were estimated. The market share[1] of PFAS-containing cosmetic products ranged from 1.1 to 1.4 %. An even more similar range was obtained after removing discontinued products from Kemiluppen (1.3 compared to 1.4 %). The PFAS-containing product share was updated from prior estimates (Henricsson 2017), specified by product categories was found to be highest for Decorative cosmetics (3.7 %), followed by Skin care, Hair care and Toiletries (0.78, 0.65 and 0.27 %, respectively). A negligible fraction of Perfumes and Fragrances contained PFAS among their ingredients (0.03 %, data based on CosmEthics).

[1] Share of number products on the market. Not based on sales data.

Table 1 below shows share of cosmetic products and product versions that contain PFAS (%) sorted according to the Cosmetics Europe categories for the emission calculations. Data is based on the total number of products and product versions containing and not containing PFAS from the CosmEthics database (entire database information included, i.e. product and product versions, EU/EEA and non-EU/EEA. Note that the CosmEthics product sub-categories were rearranged into Cosmetics Europe product categories and ambiguous product sub-categories such as "other" were removed.

Table 1 Share of cosmetic products and product versions containing PFAS

Product category (Cosmetics Europe)	**Total number of products and product versions**	**Total number of cosmetic products and product versions containing PFAS**	**Share of cosmetic products and product versions containing PFAS (%)**
Decorative cosmetics	29118	1068	3.67
Hair care	21938	142	0.65
Perfumes and Fragrances	3637	1	0.03
Skin care	40103	314	0.78
Toiletries	17844	49	0.27
Total	112639	1574	1.40

2.2 Main identified PFAS substances

The different databases were consulted to get an overview of the identity and frequency of occurrence of PFAS (i.e. compounds with at least one -CF2) in cosmetic products. About 170 unique PFAS ingredients potentially occurring in cosmetic products were identified within the cosmetic ingredient database (CosIng). 42 of these were present in products within three European cosmetic databases, among which polytetrafluoroethylene (PTFE; a PFAS polymer) and C9-15 fluoroalcohol phosphate were most frequent. Analysis of the data shows that three out of the top ten listed PFAS among all considered cosmetic databases are under current or pending restriction.

Annex 1 shows more details on PFAS INCI names found in cosmetic products in the different databases.

2.3 Functions of PFAS in cosmetic products

Table 2 and Figure 1 identified functions in cosmetics are mentioned. Most frequently occurring for these PFAS are the functions, skin conditioning, binding and solvent.

Table 2 Functions in cosmetics (according to CosIng) of the most frequent PFAS in the three cosmetic databases.

PFAS	Function from CosIng
PTFE	Bulking
C9-15 fluoroalcohol phosphate	Skin conditioning
Perfluorodecalin	Detangling Skin conditioning Solvent
Perfluorooctyl triethoxysilane	Binding
Perfluorononyl dimethicone	Skin conditioning
Polyperfluoromethylisopropyl ether	Skin conditioning
Hydrofluorocarbon 152a	Propellant
Octafluoropentyl methacrylate	Binding
Acetyl trifluoromethylphenyl valylglycine	Skin conditioning
Methyl perfluorobutyl ether	Solvent Visocity controlling

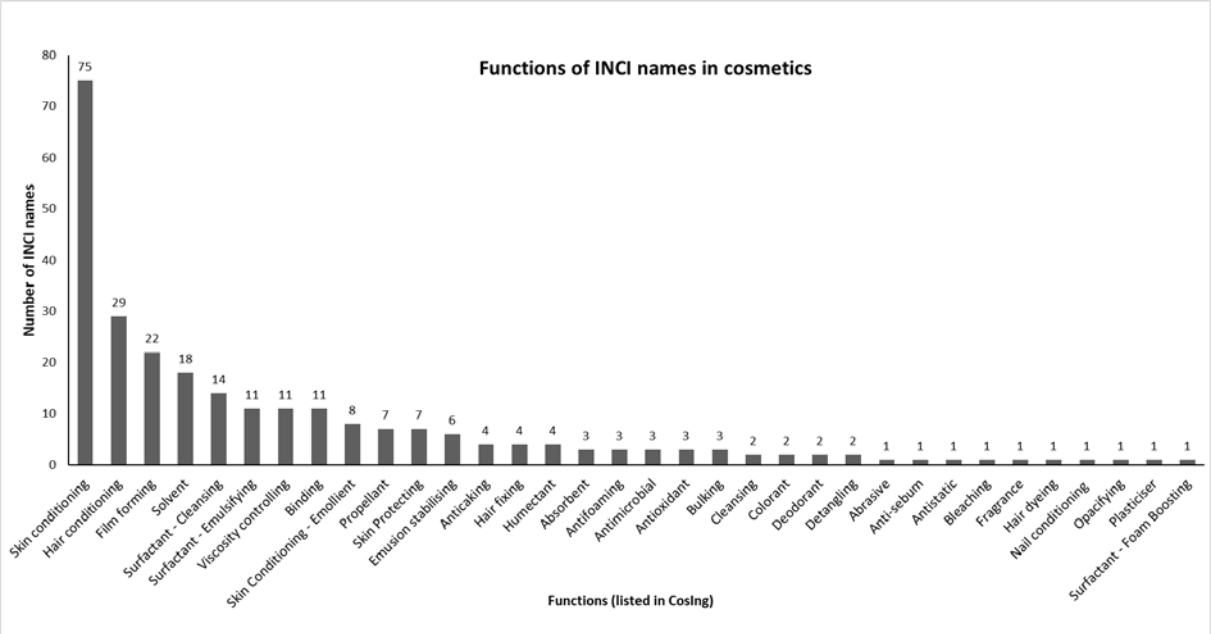

Figure 1 Functions of INCI names in cosmetics, searched for 169 INCI names in total in the CosIng database, for 9 INCI names the function section was empty or "not reported" was given as information, Total function count surpasses 160, as several INCI names have several listed functions.

3 Market data

In 2019, the European market for cosmetics had a retail value of about €80 billion Euro.[2] The import value was €6.5 billion, or 8 percent the European market. There was no growth in market value in real terms in three-year period ending in 2019. There are some regional differences, with growth in market value in some Eastern European countries and declining market value in some Western European countries. The market shares and EEA market value per cosmetic product category is presented in Table 3.

Table 3 EEA cosmetic products market 2019, Retail Sales Prices (RSP including VAT) and market share by product category; data from Cosmetics Europe (2020) on European market (70.84 billion Euros, EU28 Norway and Switzerland) subtracting the RSP from the United Kingdom and Switzerland (10.657 and 1.965 billion Euros); the percentages are also based on Retail Sales Prices.

	Product category	Percent (%)	Retail Sales Price (bn Euro)
Market share 2019 by product category	Skin Care	27.1	18.22
	Toiletries	24.8	16.67
	Hair Care	18.7	12.57
	Perfumes and Fragrances	15.4	10.35
	Decorative Cosmetics	14.0	9.41
Total EEA market*	all product categories	100.0	67.22

**EU27 and Norway (EEA without Lichtenstein and Iceland)*

Based on these data on market value per product category and assumptions on price per kg of product (see original report for more details) the annual tonnage per cosmetic product category was estimated (Table 4). These estimates were used together with data on share of products per category that contain PFAS and analytical data on PFAS concentrations to estimate annual emission quantities.

Table 4 Calculated total amount (metric tonnes) of cosmetic products sold per year in 2019 in the EEA; data based on assumptions and Retail Sales Price, as well as market share from Cosmetics Europe as well as assumptions and data from the CosmEthics database.

Product category	Total amount of products (thousand tonnes/year in 2019)
Skin Care	273
Toiletries	1110
Hair Care	838
Perfumes and Fragrances	77.6
Decorative Cosmetics	18.8
Total EEA market*	2320

**EU27 and Norway (i.e. EEA without Lichtenstein and Iceland)*

[2] Cosmetics Europe (2020). Market Performance 2019 - European Cosmetic, Toiletry & Perfumery Data: 1-34.

4 Emissions

Generally, four parameters have to be considered calculating a chemical's emission, in this case for PFAS (E_{PFAS} in kg/year) from products (see Equation):

- the concentration of a chemical in the products (C_{PFAS} in µg PFAS/g product),
- the total amount, or tonnage of the products sold per year ($A_{products}$ in tons/year),
- the share of products containing the chemical ($f_{PFAS\ products}$) and
- the fraction of the chemical released from the product into a certain compartment ($f_{release}$), (e.g. wastewater or solid waste etc.).

$$E_{PFAS}\left[\frac{kg}{year}\right] = C_{PFAS}\left[\frac{\mu g}{g}\right] \times A_{products}\left[\frac{t}{year}\right] \times f_{PFAS\ products} \times f_{release} \times 10^{-3}$$

The factor 10^{-3} in the equation is a conversion factor from g/year to kg/year. The $f_{release}$ part can be neglected (i.e. set equal to one) in order to calculate the total emission or total content of PFASs in the products.

Table 5 demonstrates emissions to wastewater and solid waste based on TF (including polymers), EOF and the sum of the targeted PFCAs (i.e. impurities). For more detailed information, see Annex 2.

Table 5 Total emissions of PFAS from use of cosmetic products (kg F/year), average-case scenario. Quantities PFAS/year are obtained by using a conversion factor of 1.4-2.0.

	Emission to wastewater	Amount to solid waste	Total
TF (including polymers)	8300 kg F/year	2700 kg F/year	11000 kg F/year
EOF	1000 kg F/year	260 kg F/year	13000 kg F/year
Sum analysed PFCAs	2.0 kg ∑PFCAs /year	0.66 kg ∑PFCAs /year	2.7kg ∑PFCAs /year

The results indicate the importance of using several analytical methods to capture the wide range of PFAS, which would otherwise be missed if only specific PFAS were measured during chemical analysis. The Skin Care product category contributed the most to the TF and sum PFCA emission estimates, while Hair Care (best- and average-case) and Decorative cosmetics (worst-case) contributed the most to the EOF emissions. A previously identified data gap in Hair Care products was also filled by measurements and emission estimates.

The emissions based on TF represents any kind of PFAS (low and high molecular weight PFAS, including polymers, non-polar and polar, as well as ionisable and non-ionisable PFAS), but can also represent inorganic fluorine if present in the product.

The EOF-based emission calculations are the best estimate for non-polymeric and polar (i.e. soluble in methanol) PFAS that are present in the cosmetic products.

The total emission estimates based on ∑PFCAs were orders of magnitude lower than TF and EOF emissions, as only a minor fraction of unintended and non-listed ingredients is reflected by the ∑PFCAs.

Emission estimates and other collected data in this study show, while subject to several uncertainties, that cosmetic products contribute to the occurrence of PFAS in the environment, both via wastewater and via solid waste.

5 Exposure

No specific data available.

Reference is made to 2 publications on general consumer exposure on PFAS, not specific for cosmetics. **Trudel, D., Horowitz, L., Wormuth, M., Scheringer, M., Cousins, I. T. & Hungerbühler, K. (2008):** "Estimating consumer exposure to PFOS and PFOA", Risk Analysis 28(2): 251-269, DOI: https://doi.org/10.1111/j.1539-6924.2008.01017.x.

Vestergren, R., Cousins, I. T., Trudel, D., Wormuth, M. & Scheringer, M. (2008): "Estimating the contribution of precursor compounds in consumer exposure to PFOS and PFOA", Chemosphere 73(10): 1617-1624, DOI: https://doi.org/10.1016/j.chemosphere.2008.08.011.

6 Alternatives

The share of PFAS containing cosmetic products is below 10 percent in all of the 108 cosmetic product subcategories included in the CosmEthics database. This suggests that PFAS can be replaced by other ingredients and do not have unique functions in cosmetics. To this conclusion comes also the POPFREE stage two project (https://www.ri.se/en/popfree/about-popfree/project-results/popfree-stage-two, latest access 22/02/2021) and it was also confirmed in an interview with a cosmetics producer (oct 2020).

At least 57 different brands (54 global) of nine different companies have declared their PFAS phase out in cosmetic products so far. PFAS phase out declaration of companies/brands might indicate that at least some likely have already actively found new formulations without PFAS that still work for the functionality of their products.

Experience from the partly targeted cosmetic product sampling based on the cosmetic databases information showed that several supposedly PFAS containing products did not list any PFAS as an ingredient.

7. Economic impacts in case of a full PFAS ban

The main categories of economic impacts of a full PFAS in cosmetic products are assumed to be product reformulation costs, substance substitution costs and costs associated with product performance loss.

Substitution costs and product performance losses have not been quantified in this study. Substitution costs are assumed to be relatively small since the share of PFAS containing cosmetic products is low (less than 10 percent) in all of the 108 cosmetic product subcategories included in the CosmEthics database. This indicates that there are economically feasible alternatives available.

Product reformulation costs are estimated to be €1.9 million per year for 20 years, or a net present value (at 4% discount rate) of €25.6 million. This estimate does not take into account that some of the products would be reformulated during the restriction implementation period also in a baseline scenario. The method and assumptions for the estimation roughly follows the ones used in the restriction proposal for D4, D5 and D6.[3] For an overview, see the bullet points below.

[3] https://echa.europa.eu/sv/registry-of-restriction-intentions/-/dislist/details/0b0236e181a55ade

- **Total number of cosmetic formulations on the EU/EEA market: 460 000.**
  - 100 000 formulations by large companies (EC, 2008).[4]
  - 360 000 formulations by SMEs, based on 60 formulations per SME (EC, 2008) and 6 000 SMEs in the European cosmetics sector.[5]
- **Number of reformulations containing PFAS: 6 440 (1 400 in large companies and 4 040 in SMEs).**
  - Share of products containing PFAS in the CosmEthics database is 1.4 percent.
- **Number of reformulations expected due to a full ban of PFAS in cosmetics: 322 (70 in large companies and 252 in SMEs).**
  - Assumed that 5 percent of the relevant products are reformulated. The assumption follows on the restriction proposal for D4, D5 and D6 which argued that for subcategories where products containing the substances proposed to be restricted represent less than 30 percent of the market, the alternatives are expected to take over their market share and very few of these products are expected to be reformulated. The share of formulations with PFAS is below 10 percent for all subcategories of cosmetics in the CosmEthics database.
- **Cost per reformulation: €380 000 for large companies and €44 000 for SMEs.**
  - Cost per reformulation estimates in the D4, D5 and D6 restriction proposal adjusted for inflation to 2020 values.
- **Total undiscounted reformulation costs: €37.6 million.**
  - Number of reformulations expected times the cost per reformulation.
- **Annual undiscounted reformulation costs: €1.9 million.**
  - Assumed that the baseline reformulation rate is 5 percent per year.

Table 6 Summary of estimated number of formulations and reformulation costs per cosmetic product category

Product category	Estimated number of formulations containing PFAS	Expected number of reformulations	Total undiscounted refomulation costs (million €)	Annual reformulation costs (million €)	Net present value of reformulation costs (million €)
Decorative	4353	218	25,4	1,3	17,3
Hair care	568	28	3,3	0,2	2,3
Perfumes & Fragrances	14	1	0,1	0,0	0,1
Skin Care	1266	63	7,4	0,4	5,0
Toiletries	239	12	1,4	0,1	0,9
Total	**6440**	**322**	**37,6**	**1,9**	**25,6**

[4] EC. (2008). Impact assessment report on simplification of the "Cosmetics Directive" – Directive 76/768/EEC. Available at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2008:0117:FIN:EN:PDF.
[5] https://cosmeticseurope.eu/cosmetics-industry/

8. Uncertainties and limitations of the study

The total number of PFAS occurring in cosmetic products and/or existing as INCI names identified in this report is likely an underestimate for the following reasons:

- One INCI name can include several different PFAS;
- It is unlikely that all PFAS INCI names in CosIng were covered during the database searches. As an example, another PFAS INCI name (polyvinylidene difluoride) was randomly found when checking CosIng for the functions in cosmetics of another INCI name (vinylidene difluoride);
- Some ingredient names on the labels of cosmetic products are not part of the CosIng database, i.e. CosIng does not reflect all ingredient names and is therefore not a complete list;
- The PFAS searches within the cosmetic database (CosmEthics, Kemiluppen, ToxFox) considered the exact PFAS/INCI name from the list, on which the received database extracts in this report are based on. However, typing errors of the ingredient names can occur both on the package labels, or when transferring the ingredient names into the database (the latter especially when done by the app-users themselves, as in ToxFox). Some examples of altered/missing parts of the INCI name on the packaging labels, that were discovered by a database administrator:
  - INCI "C9-15 fluoroalcohol phosphate" found in the plural wordform, i.e. "C9-15 fluoroalcohol phosphates" on the label;
  - INCI "Hydrofluorocarbon 152A" found without the "A", i.e. "Hydrofluorocarbon 152" on the label.

All of the aforementioned factors have the potential to contribute to an underestimation of the total number of PFAS in cosmetic products. There is also the risk of missing PFAS which occur unintentionally (i.e. as impurities not listed among the ingredients), but which are nevertheless detected by targeted PFAS analysis.

At the same time, the products listed in the cosmetic databases reflect the product information as entered into the system, meaning that there could be even an overestimation of PFAS. The below uncertainties could lead to both an, over- and underestimation of PFAS in cosmetic products:

- Outdated products, both taken from the market or with meanwhile changed ingredients might still be part of the databases, even though some databases are actively updating this information. The targeted sampling showed that some products previously listing PFAS as ingredients did not contain the according INCI anymore.
- At the same time, the latest products might still be missing in the current database extracts due to missing or too few scans.
- Generally, it is unlikely that all products available at the EEA market are in the databases (reflected by the different number of registered products in the databases).
- Especially for ToxFox, there is the risk of missing or faulty classification, i.e. both missing products that are cosmetic products and including products falsely as cosmetic products that are e.g. hygiene products instead.

The information of the consulted database for technical products (SpecialChem) is afflicted by the same uncertainties and limitations as mentioned for the cosmetic databases.

Products in the cosmetic databases were assumed to be representative of the entire EEA market. However, this is only true in cases where the products are sold in all EEA countries and where product scans/registrations are not conducted by app users located outside EEA countries. Producers may have different products in different countries, depending on consumer preferences (e.g. Nordic countries

prefer less perfume than other European countries). When it comes to cosmetic legislation, there are very few country-specific laws for chemical ingredients (among the exemptions is Denmark's restriction on parabens), which might influence the ingredient lists. The previous information was received by the Swedish Medical Products Agency (MPA, personal communication with Josefin Backman, August 2020) and is consistent with information obtained from inquiries to several cosmetic producers (July 2020).

Uncertainties related to the emission estimates

There are several uncertainties and limitations connected to the emissions estimates. These are listed and sorted below according to the four major parameters driving the emission calculations Within each parameter, the influence of the uncertainty on the emission estimates was sorted according to perceived relative importance.

Total amount of cosmetic products sold per year

Ideally the amount or volume of cosmetic products sold per year would exist as a recorded tonnage value. As this information is not available, several assumptions on different parameters leading to this parameter had to be made that partly have a big influence on the emission estimates. Therefore, this parameter is considered the most uncertain among the four overarching one's going into the emission calculations.

The two parameters with the biggest influence on the cosmetic product amount sold per year are likely the price per product and the size of a product. A 10 % change (e.g. increase) of the two parameters would each result in a change of 10 % in the total emission estimates (i.e. in case of the price a decrease and in case of the size an increase). In detail the uncertainties that have to be considered in connection with the total amount of cosmetic products sold per year are:

1. Assumption on an average price per product category (based on estimates and price screening) might be flawed due to a great price span among and within different product sub-categories, which also might be of different importance for the overall product categories;
2. An average price assumption cannot reflect country specific prices, which might vary greatly and might have a huge influence on the average price, or the related tonnages sold per country;
3. Assumption on an average size of a product (mL or g) might be flawed due to a great span among and within different product sub-categories,
4. Products bought outside the EEA and are directly imported by the customers are not captured by the sales data;
5. Retail Sales Price statistics were missing for Lichtenstein and Iceland, thus the EEA emission estimates are just an approximation and are likely a slight underestimation;
6. It is assumed that all products sold per year are used during a year;
7. Retail Sales Price data do not necessarily reflect the product volume (tonnages), especially over time, i.e. an increase in Retail Sales Price could also show an increase in value of the products.

The PFAS concentrations (EOF/TF) in cosmetics products

The major concern for the product concentration is how representative the analysed samples are for all cosmetic products that contain PFAS. Further sources for uncertainties are (in order of decreasing importance):

1. The low number of samples compared to the vast number of cosmetic products, even though this is one of the largest analytical studies on PFAS in cosmetic products;
2. Missing measurements within the product category Toiletries - for which the same concentrations as in Hair Care were assumed in the different scenarios - might result in a greater uncertainty of emissions from all cosmetic products;
3. Products were not measured from all sub-categories within the different product categories and important sub-categories might be missed out;
4. The assumption that all products within the sub-category contain an equal concentration of PFAS as the average/min/max of the measured products may be an oversimplification;
5. Emissions estimates based on ∑PFAS or ∑PFCA concentrations are likely to be underestimated, because target PFAS analysis only covers a fraction of PFAS which may be present in a product (and in most cases none of the listed PFAS ingredients);
6. Emission estimates derived from EOF measurements may be underestimated in products containing polymers and other highly non-polar PFAS, which are not extractable with methanol;
7. Inorganic fluorine is expected to occur at low or negligible concentrations relative to organic fluorine (in PFAS-containing products), but it cannot be ruled out that TF emission estimates may be overestimated in cases where large quantities of inorganic fluorine are present;
8. A potential underestimation of PFAS as impurities in the share of products not listing PFAS as ingredients, which could increase the share of products containing PFAS (one of the two blank samples not listing any PFAS contained TF); measurement of a wider range of supposedly PFAS-free product could be helpful here;
9. A potential underestimation of Perfumes and Fragrances (assumed concentration 0, as so few products contained PFAS(s) as ingredients), if of relevance, likely only for PFAS as impurities;
10. Analytical uncertainties, which in comparison to the above mentioned are quantifiable and appear within an acceptable range.

PFAS released

1. All total emissions are likely underestimated, as emissions during production are not considered;
2. Emissions to wastewater and solid waste might be flawed, as a reduction of emission due to PFAS release to other compartments (such as air, while product application) or skin-uptake and ingestion by consumers (the latter especially in the case of lip-products) was considered zero;
3. Total emissions of PFAS were split between solid waste and wastewater and were based partly on assumptions, so the emissions might be shifted towards either;
4. Statistics for consumer habits on cosmetics' removal were not available for all product categories, for which assumptions had to be made;
5. Statistics for consumer habits on cosmetics' removal were paired with assumptions to obtain one value per cosmetic product category only and also for the different emission scenarios;
6. Data on product disposal before they are completely used up and on the fraction of the cosmetic product which remains inside the package when used up could improve the emission

estimates to wastewater and solid waste; i.e. likely lower the emissions to wastewater and increase the emissions to solid waste (only in the best-case scenario, there was the attempt to account for these additional disposal fractions: by lowering the wastewater fraction by 10 % compared to the average-case scenario and considering this to go into solid waste instead);

7. Emissions to wastewater and solid waste might be flawed, as the consumer habits on cosmetics' removal date a few years back. There is an upcoming trend towards multiple-use and washable pads/whips for make-up removal instead of single-use cotton/pads/whips. The multiple-use products are promoted as more environmentally friendly compared to single-use products in terms of saving water/resources during cotton production. However, this ensures that the products are released into the wastewater when washing the reusable pads. In future, consumer habit studies on cosmetic removal should include the use of multiple-use/washable removal products as an additional answer option in questionnaires.

Product share containing PFAS

The share of products containing PFAS is considered the most certain compared to the other major parameters. Besides the above-mentioned database uncertainties, the following is true for PFAS-containing product share:

1. Potential slight over- or underestimation of to the share of products containing PFAS (missing PFAS or including replaced products), although it is the best estimate possible based on the biggest cosmetic database and the different databases seem to match (at least for the product share over all products);
2. Potentially uncertain, when taking the same current product share in future due to changes in production/products placed of the market (new database information should be considered in a few years for emission calculations);
3. Potential underestimation of the product share containing PFAS and the emissions due to a share of products that contain PFAS as impurities, but that are not listing PFAS as ingredients;
4. Potential for slight deviation of the product share in the different categories due to rearrangement of sub-categories from CosmEthics' into Cosmetics Europe's classification (unlikely to have a big influence at all; also probably a very minor source of failure, especially as a terminology and classification list provided by Cosmetics Europe was used for this)

Annex 1 PFAS in Cosmetic products

PFAS INCI names found in cosmetic products in the different databases, shown are only the most frequent found PFAS among all databases and the top ten ranked PFAS within each database (CosmEthics, Kemiluppen and ToxFox), rank within database (the number of products in which the according PFAS was found). Note that a hyphen (-) equals not found in this database, grey cells represent the top 10 ranked substances of all databases and/or within a database.)

PFAS INCI names	CAS No	EC/List no	Fluorinated carbons	Covered by any existing or pending PFAS restriction	Rank CosmEthics (number of products)	Rank Kemiluppen (number of products)	Rank ToxFox (number of products)
PTFE	9002-84-0	618-337-2	fluoropolymer	**No**	1 (541)	1 (64)	1 (321)
C9-15 fluoroalcohol phosphate	223239-92-7	-	C9-C15	Existing, included in PFOA restriction in the Stockholm Convention/ POPs Regulation	3 (208)	3 (27)	3 (76)
Perfluorodecalin	306-94-5	206-192-4	C10/fully F	**No**	6 (64)	5 (13)	4 (70)
Perfluorooctyl triethoxysilane	51851-37-7	257-473-3	C6	Existing, included in 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)silanetriol and any of its mono-, di- or tri-O-(alkyl) derivatives	2 (232)	4 (14)	-
Perfluorononyl dimethicone	-	-	C9	Existing, included in PFOA restriction in the Stockholm Convention/ POPs Regulation	4 (111)	11.5 (5)	5 (60)
Polyperfluoromethylisopropyl ether	69991-67-9	615-044-1	C4	**No**	8 (55)	7 (9)	6 (55)
Hydrofluorocarbon 152a	75-37-6	200-866-1	C1	**No**	5 (103)	16.5 (3)	2 (86)
Octafluoropentyl methacrylate	355-93-1	206-596-0	C4	**No**	12 (31)	2 (31)	-
Acetyl trifluoromethylphenyl valylglycine	379685-96-8	609-497-4	C1	**No**	7 (63)	7 (9)	-
Methyl perfluorobutyl ether	163702-07-6	-	C4	**No**	11 (34)	7 (9)	-
Polyperfluoroethoxymethoxy difluoroethyl PEG phosphate	-	-	C1+C2	**No**	9 (47)	11.5 (5)	-
Ammonium C6-16 perfluoroalkylethyl phosphate	65530-72-5 /	685-094-7 /	C6-C16	Existing PFOA, pending C9-C14 PFCAs precursors	14 (25)	10 (6)	-

PFAS INCI names	CAS No	EC/List no	Fluorinated carbons	Covered by any existing or pending PFAS restriction	Rank CosmEthics (number of products)	Rank Kemiluppen (number of products)	Rank ToxFox (number of products)
	65530-71-4 / 65530-70-3	809-881-3 / 809-882-9					
Methyl perfluoroisobutyl ether	163702-08-7	605-340-9	C4	**No**	16 (23)	9 (7)	-
Trifluoropropyldimethyl/trimethylsiloxysilicate	-	-	C1	**No**	10 (42)	23.5 (1)	-
Polyperfluoroisopropyl ether	25038-02-2	626-882-2	C3	**No**	21.5 (7)	19 (2)	11 (1)
Trifluoromethyl C1-4 alkyl dimethicone	-	-	C1	**No**	25 (6)	-	8 (7)
PEG-8 trifluoropropyl dimethicone copolymer	-	-	C1	**No**	30 (3)	-	9 (2)
HC yellow no. 13	10442-83-8	443-760-2	C1	**No***	-	-	7 (16)
Polysilicone-7	146632-08-8	-	C8	Existing PFOS precursor	-	-	11 (1)
Polysilicone-10	-	-	unclear	unclear	-	-	11 (1)

Annex 2 Detailed emission calculations

Estimates for total emissions, emissions to wastewater and solid waste, each in a best-, average- and worst-case scenario for the different cosmetic product categories based on the total fluorine (TF) measurements. Annual emission estimates (kg F/year) f or the EEA without Lichtenstein and Iceland, or correspondingly the EU27 and Norway. Numbers in bold present cosmetic product category contributing most to the total, wastewater or solid waste emission, respectively and in each certain scenario; All values are rounded to two significant figures. Quantities PFAS/year are obtained by using a conversion factor of 1.4-2.0.

	Best-case TF emissions (kg F/year)			**Average-case TF emissions (kg F/year)**			**Worst-case TF emissions (kg F/year)**		
Product category	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste
Skin Care	**8.0**	**5.3**	2.7	**8200**	**6200**	**2000**	**29000**	**29000**	0
Toiletries	1.0	0.82	0.21	560	500	58	1500	1500	0
Hair Care	1.9	1.5	0.35	1000	930	86	2700	2700	0
Perfumes and Fragrances	0	0	0	0	0	0	0	0	0
Decorative Cosmetics	5.6	1.0	**4.6**	1200	650	570	4100	4100	0
Total	17	8.6	7.9	11000	8300	2700	38000	38000	0

Estimates for total emissions, emissions to wastewater and solid waste, each in a best-, average- and worst-case scenario for the different cosmetic product categories based on the extractable organic fluorine (EOF) measurements. Annual emission estimates (kg F/year) for the EEA without Lichtenstein and Iceland, or correspondingly the EU27 and Norway. Numbers in bold present cosmetic product category contributing most to the total, wastewater or solid waste emission, respectively and in each certain scenario; all values are rounded to two significant figures. Quantities PFAS/year are obtained by using a conversion factor of 1.4-2.0.

	Best-case EOF emissions (kg F/year)			**Average-case EOF emissions (kg F/year)**			**Worst-case EOF emissions (kg F/year)**		
Product category	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste
Skin Care	0.17	0.11	0.059	11	8.7	2.8	78	78	0
Toiletries	13	10	2.7	310	270	32	570	570	0
Hair Care	**24**	**20**	**4.4**	**560**	**510**	47	1000	1000	0
Perfumes and Fragrances	0	0	0	0	0	0	0	0	0
Decorative Cosmetics	0.11	0.020	0.092	380	200	**180**	**3400**	**3400**	0
Total	37	30	7.3	1300	1000	260	5100	5100	0

Estimates for total emissions, emissions to wastewater and solid waste, each in a best-, average- and worst-case scenario for the different cosmetic product categories based on the on the targeted PFAS measurements. Annual emission estimates as ∑PFCA (kg ∑PFCAs/year) for the EEA without Lichtenstein and Iceland, or correspondingly the EU27 and Norway. Numbers in bold present cosmetic product category contributing most to the total, wastewater or solid waste emission, respectively and in each certain scenario; All values are rounded to two significant figures.

Product category	**Best-case ∑PFCA emissions (kg ∑PFCAs /year)**			**Average-case ∑PFCA emissions (kg ∑PFCAs /year)**			**Worst-case ∑PFCA emissions (kg ∑PFCAs /year)**		
	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste	TOTAL	Waste water	Solid waste
Skin Care	0	0	0	**2.7**	**2.0**	**0.64**	**20**	**20**	0
Toiletries	0	0	0	0	0	0	0	0	0
Hair Care	0	0	0	0	0	0	0	0	0
Perfumes and Fragrances	0	0	0	0	0	0	0	0	0
Decorative Cosmetics	0	0	0	0.035	0.019	0.016	0.24	0.24	0
Total	0	0	0	2.7	2.0	0.66	21	21	0