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Use of per and Polyfluoroalkyl Substances (PFAS) in Cosmetics and their effects on human health

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Abstract:

Per- and polyfluoroalkyl substances (PFAS) are a diverse group of synthesized chemicals used in a wide range of consumer and industrial products. It consists of a group of more than 4700 chemical compounds for which the characteristic perfluorinated carbon moiety confers hydrophobic chemical properties and environmental persistence. Certain PFAS are also intentionally added as ingredients in some cosmetic products, including lotions, cleansers, nail polish, shaving cream, foundation, lipstick, eyeliner, eyeshadow, and mascara. These PFAS are used in cosmetics to conditioning and smooth the skin, making it appear shiny, or to affect product consistency and texture. Some common PFAS used as ingredients in cosmetics include PTFE (polytetrafluoroethylene), perfluorooctyl triethoxysilane, perfluorononyl dimethicone, perfluorodecalin, and perfluorohexane. These highly persistent and potentially toxic class of chemicals, are added to cosmetics to increase their durability and water resistance.

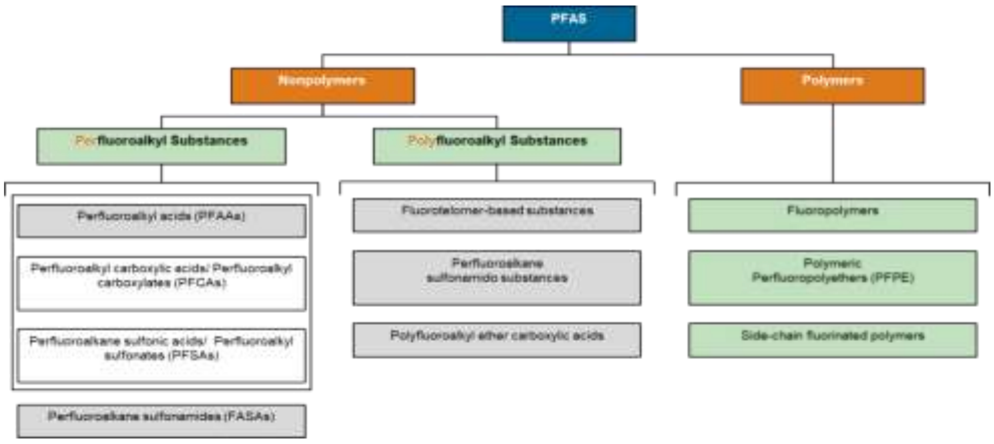
Key words: PFA, cosmetic, environment, chemicals.

Introduction:

Since the 1950s, PFA compounds have been widely used in industrial products such as fire-fighting foams and consumer goods such as coated fabrics, carpets, utensils and other food packaging and many others. Some studies have reported the use of PFAS in cosmetics in Europe and Asia. The PFAS in cosmetics can pose a risk to human health through direct and indirect exposure, as well as pose a risk to ecosystem health throughout the life cycle of these products. PFAS are used in various cosmetics products including lotions, cleansers, nail polish, shaving cream, foundation, lipstick, eyeliner, eyeshadow, and mascara for their properties such as hydrophobicity and film-forming ability, and are thought to improve product wear, durability, and spreadability. Additional claimed benefits are increased skin absorption of the product and improvements in the appearance or texture of skin. Some common PFAS used as ingredients in cosmetics include PTFE (polytetrafluoroethylene), perfluorooctyl triethoxysilane, perfluorononyl dimethicone, perfluorodecalin, and perfluorohexane. But these chemical are highly persistent and potentially toxic in nature These synthetic chemicals consist perfluorinated carbon moiety with hydrophobic chemical properties and environmental persistence.. In this paper we will be discuss about the structure and adverse effects of PFA compounds.

Chemical Structure and Classification:

Carbon can form up to four bonds with other atoms. In PFA compounds, Carbon (C) attached with fluorine (F). This C-F bond is highly durable and a key factor behind the problems posed by PFAS and is also the cause of its desirable technical properties. Polymers that are made by repeating subunits called monomer are often used as starting materials for the production of other PFA chemicals. The best known fluoropolymer is polytetrafluoroethylene (PTFE), was discovered by Roy Plunkett on April 6, 1938. PFA is a semi-crystalline material with a maximum achievable crystallinity of 60%. PFA chemicals can also exist in multiple states such as acids, anions, cations, and salts that have important effects on their physical and chemical properties. The anionic form is the most prevalent form in the environment. Non-polymeric PFASs include perfluorinated and polyfluorinated materials. If carbon is bonded only to fluorine excluding functional groups, it is said to be perfluorinated. While in polyflorinated, some carbon bonds are bonded to functional groups or to something other than fluorine and is also considered unsaturated with respect to F. Hydrogen is the most common other bond. “PFAS” stands as a default plural acronym of PFA means "per- and polyfluoroalkyl substances" and a single compound cannot be simultaneously unsaturated and saturated with respect to fluorine. Both perfluoroalkyls and polyfluoroalkyls fall into classes with relatively similar functional group behaviour. Two broad classes are fluoroalkyl acids and fluoroalkanesulfonamides are related to perfloroalkyl family. These large classes are then subdivided again based on functional groups/moieties. Interstate technology regulatory council gave a broad classification for PFAS. There are over than 425 acknowledged nonpolymer moiety classification groups.



Picture courtesy of The Interstate Technology Regulatory Council

In 2017, Wang et al published an iconic chart covering the number of papers published on various PFAS groups.

Literature reviewed for PFAS used in Cosmetics:

Various types of fluoroalkyl substances including perfluoroalkyl and polyfluoroalkyl and their compounds or mixtures are used in cosmetic products. These fluorinated substances and compounds contain residues of the basic perfluoroalkyl acids or perfluorocarboxylic acids (PFCA). The most important PFCA is perfluorooctanoic acid (PFOA) with a perfluoroalkyl chain of seven carbon atoms. Fluoroalkyl substances with longer perfluoroalkyl chains than PFOA are considered to be very persistent, highly bio-accumulative and toxic. Fujii et al. (2013) conducted a study on PFCA concentrations in different types of cosmetic products. They selected 24 different cosmetic products for face and nails, including nine different sunscreens, for which the ingredient list indicated that the product contained either polyfluoroalkyl phosphate esters (PAP) or other fluorinated substances. The study was conducted on cosmetic products purchased in Japan. The results disclosed that 87% (13 out of 15) of cosmetic products (excluding sunscreen), contains PAP or other types of fluorinated substances having concentrations of PFCA. For sunscreens alone, this result was 89% (8 out of 9). The highest concentrations of PFCA were found in sunscreens followed by foundation. The GSP Institute (2014) has prepared an overview of fluoroalkyl substances and other fluorinated compounds in cosmetic products, based on data from the Skin Deep database. In Sweden, Naturskyddsföreningen (2017) (Nature Conservation Association) analysed 22 cosmetic products from nine different brands for PFAS content. Out of the selected products PFAS was found in 20 of the products, with variation. One product in particular contained large amounts of different PFAS. 17 products contained PFOA, 12 contained PFNA and 10 contained PFDA. Based on information from the above-mentioned studies, a Lund University thesis (Henricsson, 2017) examined the presence of PFAS in cosmetic products on the Swedish market. In the survey, 30 brands were selected for examination, where ingredients lists for a total of 1,354 products in the categories sunscreen, foundation, powder, moisturizer, eyeliner and eye shadow were reviewed. Out of the 1,354 products, 59 (4.4%) of the products had declared contents of PFA.

Hazardous effects of PFAS on human:

Studies on the prevalence of PFAS in cosmetics are scarce. According to published studies, the content of certain PFAS—either as ingredients or impurities—in cosmetics ranges from a few parts per billion to hundreds of parts per million. It may be difficult to detect and quantify all PFAS that may be present in cosmetics since the chemical compound's unique "fingerprint" or analytical standard may not be accessible.

There is also limited research on whether PFAS in cosmetics are absorbed through the skin at levels that could be harmful to human health. . In a 2018 study the sole risk assessment that has assessed the presence of PFAS in cosmetics was done by Denmark's Environmental Protection Agency and focused on a few PFAS that were unintentionally present in cosmetics. The study concentrated on five distinct PFAS contaminants that were found in the most variety of cosmetic items and at reasonably significant levels. The scientists came to the conclusion that the amounts of PFAS in each of the examined goods are not likely to endanger customers' health. The low amount of information from this and other published studies prevents from drawing firm conclusions about the potential health dangers of PFAS in cosmetics. A large number of epidemiological studies have evaluated possible associations between perfluoroalkyl exposure and a wide range of adverse health outcomes. However, most of the studies have focused on PFOA and/or PFOS; fewer studies have evaluated a smaller number of potential health outcomes for the remaining 10 perfluoroalkyls included in this toxicological profile. In 2017, the International Agency for Research on Cancer (IARC) classified perfluorooctanoic acid (PFOA), as a possible human carcinogen based in part on weak epidemiologic evidence of associations with kidney and testis cancers in people who had been exposed to the substance frequently. Perfluoroalkanoic acids (PFCA) and their salts with different chain lengths can inter alia activate "peroxisome proliferator-activated receptor α" (PPARα) in liver cells, and therefore they may cause peroxisome proliferation, enlarged liver and increased fatty acid oxidation, etc. (Ikeda et al., 1985).

A toxicological profile developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Environmental Protection Agency (EPA) reported that based on a number of factors the available epidemiological studies suggest associations between perfluoroalkyl exposure and several health outcomes; however, cause-and-effect relationships have not been established for these outcomes:

1. Pregnancy-induced hypertension/pre-eclampsia (PFOA, PFOS)
2. Increases in serum hepatic enzymes, particularly alanine aminotransferase (ALT), and decreases in serum bilirubin levels (PFOA, PFOS, PFHxS)
3. Increases in serum lipids, particularly total cholesterol and low-density lipoprotein (LDL) cholesterol (PFOA, PFOS, PFNA, PFDA)
4. Decreased antibody response to vaccines (PFOA, PFOS, PFHxS, PFDA)

These health outcomes include osteoarthritis in women less than 50 years of age (PFOA, PFOS). Additionally, associations between serum PFOA and PFOS and decreases in glomerular filtration rate and increases in serum uric acid levels and between serum PFOA, PFOS, PFHxS, and PFNA and increased risk of early menopause have been observed; these effects may be due to reverse causation, where the effect (disease) causes the change in serum perfluoroalkyl levels (exposure).

Conclusion: Long time exposure with chemicals creates hazardous effects on health despite use of chemicals increases day by day. Now- a-days cosmetics are also essential part of life in females therefore avoiding use of chemicals is not possible but we need to prepare better alternatives of these products and also avoid using those cosmetics that contains such hazardous chemicals.

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