

Safety Assessment of Alkyl PEG/PPG Ethers as Used in Cosmetics

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Monice M. Fiume¹, Bart Heldreth², Wilma F. Bergfeld³,
Donald V. Belsito³, Ronald A. Hill³, Curtis D. Klaassen³,
Daniel C. Liebler³, James G. Marks Jr³, Ronald C. Shank³,
Thomas J. Slaga³, Paul W. Snyder³, and F. Alan Andersen⁴

Abstract

The Cosmetic Ingredient Review (CIR) Expert Panel assessed the safety of 131 alkyl polyethylene glycol (PEG)/polypropylene glycol ethers as used in cosmetics, concluding that these ingredients are safe in the present practices of use and concentration described in this safety assessment when formulated to be nonirritating. Most of the alkyl PEG/PPG ethers included in this review are reported to function in cosmetics as surfactants, skin-conditioning agents, and/or emulsifying agents. The alkyl PEG/PPG ethers share very similar physiochemical properties as the alkyl PEG ethers, which were reviewed previously by the CIR Expert Panel and found safe when formulated to be nonirritating. The alkyl PEG ethers differ by the inclusion of PPG repeat units, which are used to fine-tune the surfactant properties of this group. The Panel relied heavily on data on analogous ingredients, extracted from the alkyl PEG ethers and PPG reports, when making its determination of safety.

Keywords

safety, cosmetics, alkyl PEG/PPG ethers

Introduction

This report assesses the safety of 131 alkyl polyethylene glycol (PEG)/polypropylene glycol (PPG) ethers (listed in Table 1) defined in the *International Cosmetic Ingredient Dictionary and Handbook* as cosmetic ingredients.¹ Most of the alkyl PEG/PPG ethers included in this review are reported to function in cosmetics as surfactants, skin-conditioning agents, and/or emulsifying agents.

The alkyl PEG/PPG ethers are not expected to metabolize to individual components; therefore, information from previous Cosmetic Ingredient Review (CIR) safety assessments on the individual alcohols is not relevant in this safety assessment. However, the CIR Expert Panel's determination that 369 alkyl PEG ethers (as well as future alkyl PEG ether cosmetic ingredients that vary from those 369 ethers only by the number of ethylene glycol repeat units) and PPGs ≥ 3 are safe as used when formulated to be nonirritating^{2,3} is relevant because these ingredients share very similar physiochemical profiles, with an internal mixture of various hydrophobicities/hydrophilicities, as expected in these sorts of alkoxy-based, surfactant-like molecules.⁴ The only difference between alkyl PEG ethers and alkyl PEG/PPG ethers is the inclusion of PPG repeat units which is simply used to fine-tune the surfactant properties of these ingredients.

Although there are very little data available on the alkyl PEG/PPG ether ingredients, data on analogous ingredients

provide a good indication of the lack of toxicity of these ingredients.

Chemistry

Definition and Structure

Alkyl PEG/PPG ethers are the reaction products of an alkyl alcohol and one or more equivalents each of ethylene oxide and propylene oxide (forming repeats of PEG and PPG, respectively; Figure 1).

The definition of each ingredient, as given in the *International Cosmetic Ingredient Dictionary and Handbook*, is provided in Table 2.¹

¹ Cosmetic Ingredient Review Scientific Analyst/Writer, Cosmetic Ingredient Review, Washington, DC, USA

² Cosmetic Ingredient Review Chemist, Cosmetic Ingredient Review, Washington, DC, USA

³ Cosmetic Ingredient Review Expert Panel Member, Cosmetic Ingredient Review, Washington, DC, USA

⁴ Former Director, Cosmetic Ingredient Review, Cosmetic Ingredient Review, Washington, DC, USA

Corresponding Author:

Lillian J. Gill, Cosmetic Ingredient Review, 1620L Street, NW, Suite 1200, Washington, DC 20036, USA.
Email: cirinfo@cir-safety.org

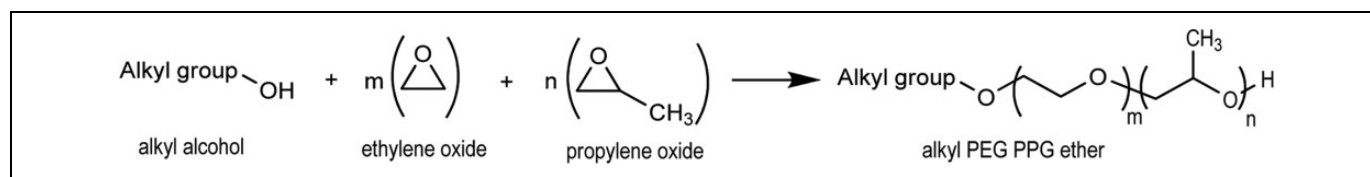


Figure 1. Alkyl polyethylene glycol (PEG)/polypropylene glycol (PPG) ether synthesis.

Table 1. Alkyl PEG/PPG Ethers Included in This Assessment.

PEG/PPG-3/6 dimethyl ether	PPG-2 C12-13 pareth-8	PPG-2-isodeceth-6
PEG/PPG-7/12 dimethyl ether	PPG-2 C12-15 pareth-6	PPG-2-isodeceth-8
PEG/PPG-9/2 dimethyl ether	PPG-4 C13-15 pareth-15	PPG-2-isodeceth-9
PEG/PPG-14/7 dimethyl ether	PPG-5 C9-15 pareth-6	PPG-2-isodeceth-10
PEG/PPG-17/4 dimethyl ether	PPG-6 C9-11 pareth-5	PPG-2-isodeceth-12
PEG/PPG-22/40 dimethyl ether	PPG-6 C12-15 pareth-12	PPG-2-isodeceth-18
PEG/PPG-27/14 dimethyl ether	PPG-6 C12-18 pareth-11	PPG-2-isodeceth-25
PEG/PPG-35/40 dimethyl ether	PPG-3 C12-14 sec-pareth-7	PPG-3-isodeceth-1
PEG/PPG-36/41 dimethyl ether	PPG-4 C12-14 sec-pareth-5	PPG-4-isodeceth-10
PEG/PPG-50/40 dimethyl ether	PPG-5 C12-14 sec-pareth-7	PPG-3-isosteareth-9
PEG/PPG-52/32 dimethyl ether	PPG-5 C12-14 sec-pareth-9	PPG-2-laureth-5
PEG/PPG-55/28 dimethyl ether	PPG-1-deceth-4	PPG-2-laureth-8
PEG/PPG-4/2 propylheptyl ether	PPG-1-deceth-5	PPG-2-laureth-12
PEG/PPG-6/2 propylheptyl ether	PPG-1-deceth-6	PPG-3-laureth-8
PEG-7/PPG-2 propylheptyl ether	PPG-1-deceth-7	PPG-3-laureth-9
PEG/PPG-8/2 propylheptyl ether	PPG-2-deceth-3	PPG-3-laureth-10
PEG/PPG-10/2 propylheptyl ether	PPG-2-deceth-5	PPG-3-laureth-12
PEG/PPG-14/2 propylheptyl ether	PPG-2-deceth-7	PPG-4-laureth-2
PEG/PPG-40/2 propylheptyl ether	PPG-2-deceth-8	PPG-4-laureth-5
PPG-2-ceteareth-9	PPG-2-deceth-10	PPG-4-laureth-7
PPG-4-ceteareth-12	PPG-2-deceth-12	PPG-4-laureth-15
PPG-10-ceteareth-20	PPG-2-deceth-15	PPG-5-laureth-5
PPG-1-ceteth-1	PPG-2-deceth-20	PPG-6-laureth-3
PPG-1-ceteth-5	PPG-2-deceth-30	PPG-25-laureth-25
PPG-1-ceteth-10	PPG-2-deceth-40	PPG-3-myreth-3
PPG-1-ceteth-20	PPG-2-deceth-50	PPG-3-myreth-11
PPG-2-ceteth-1	PPG-2-deceth-60	PPG-2-PEG-11 hydrogenated lauryl alcohol ether
PPG-2-ceteth-5	PPG-4-deceth-4	PPG-3-PEG-6 oleyl ether
PPG-2-ceteth-10	PPG-4-deceth-6	PPG-9-steareth-3
PPG-2-ceteth-20	PPG-6-deceth-4	PPG-23-steareth-34
PPG-4-ceteth-1	PPG-6-deceth-9	PPG-30-steareth-4
PPG-4-ceteth-5	PPG-8-deceth-6	PPG-34-steareth-3
PPG-4-ceteth-10	PPG-14-deceth-6	PPG-38-steareth-6
PPG-4-ceteth-20	PPG-6-decyltetradeceth-12	PPG-1 trideceth-6
PPG-5-ceteth-20	PPG-6-decyltetradeceth-20	PPG-1-trideceth-13
PPG-8-ceteth-1	PPG-6-decyltetradeceth-30	PPG-4-trideceth-6
PPG-8-ceteth-2	PPG-13-decyltetradeceth-24	PPG-6-trideceth-8
PPG-8-ceteth-5	PPG-20-decyltetradeceth-10	Propylene glycol capreth-4
PPG-8-ceteth-10	PPG-9-ethylhexeth-5	Propylene glycol isodeceth-4
PPG-8-ceteth-20	PPG-1-isodeceth-4	Propylene glycol isodeceth-12
PPG-2 C9-11 pareth-5	PPG-1-isodeceth-6	Propylene glycol laureth-6
PPG-2 C9-11 Pareth-7	PPG-1-isodeceth-7	Propylene glycol oleth-5
PPG-2 C9-11 pareth-8	PPG-1-isodeceth-9	

Abbreviations: PEG, polyethylene glycol; PPG, polypropylene glycol.

PPG-2-laureth-5 represents one of the simplest ingredients in this review as the reaction product of lauryl alcohol, 5 equivalents of ethylene oxide, and 2 equivalents of propylene oxide.

Each of the alkyl PEG/PPG ethers is a surfactant-like molecule, with a chain structure that has a hydrophobic end and a

hydrophilic end. Principally, these ingredients differ by variation in the alkyl chain length at the hydrophobic end and the number of alkoxide (PEG and PPG) repeat units at the poly-alkoxide, hydrophilic end. The structures in this report are drawn as block-type, alkoxide polymers only for simplicity's

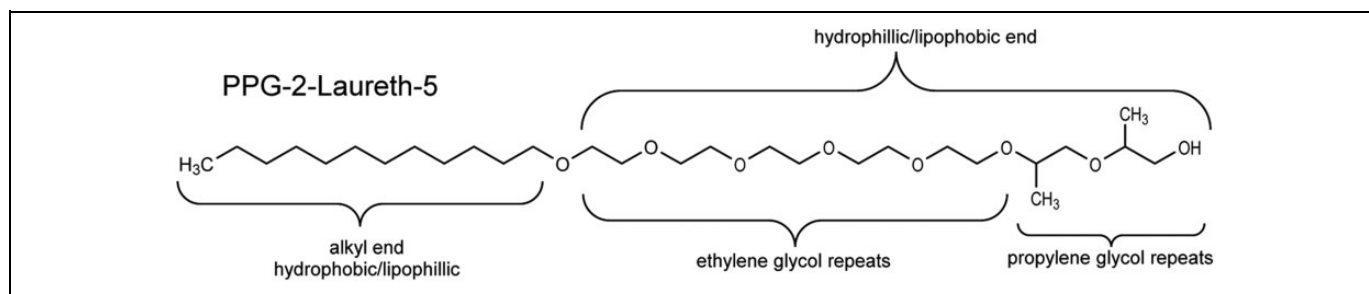


Figure 2. Alkyl polyethylene glycol (PEG)/polypropylene glycol (PPG) ether structure—for example, PPG-2-laureth-5.

sake. The actual order of alkoxide repeats in each ingredient, and from each source of an ingredient, may be block, alternating, or random.

There are a number of nomenclature conventions to be aware of in this group. For example, PEG-4-PPG-7 C13/C15 alcohol is an ingredient wherein the alkyl chain is variably 13 or 15 carbons long (“C13/C15 alcohol”), and the polyalkoxide end consists of an average of 4 ethylene glycol repeats and 7 propylene glycol repeats (“PEG-4-PPG-7”). PPG-2-laureth-5 is an ingredient (as shown in Figure 2) wherein the alkyl chain is derived from lauryl alcohol (ie, is 12 carbons long; “laur”) and the polyalkoxide end consists of an average of 5 ethylene glycol repeats (“eth-5”) and 2 propylene glycol repeats (“PPG-2”). As an example of a further variation in the naming convention, PEG/PPG-40/2 propylheptyl ether is an ingredient wherein the hydrophobic end is a 7-carbon alkyl chain (“heptyl”), with a 3-carbon branch at the 2-position (“propyl”; this naming convention indicates a Guerbet alcohol and thus substitution at the 2 position), and the poly-alkoxide end is comprised of an average of 40 ethylene glycol repeats and 2 propylene glycol repeats (“PEG/PPG-40/2”).

The dimethyl ethers are distinct in this group by being capped at both ends with methyl groups, instead of having 1 alkyl chain at 1 end. For example, PEG/PPG-3/6 dimethyl ether is an ingredient wherein 1 carbon is at each end of a polyoxide chain, comprised of an average of 3 ethylene glycol repeats and 6 propylene glycol repeats.

Physical and Chemical Properties

Physical and chemical properties data on the alkyl PEG/PPG ethers are provided in Table 3.⁵⁻²⁶ Very few published data on specific properties were available, other than most of the alkyl PEG/PPG ethers are clear to slightly yellow liquids.

The alkyl PEG/PPG ethers, such as alkoxylate polymers, are generally not defined as a single compound but as a mixture of a homologous series with a medium-range molecular weight and a specific percentage by weight of the hydrophobic tail.²⁷ The degree of hydrophobicity and hydrophilicity are fine-tuned by the components that make up each ether. The hydrophobicity of the product can be controlled by the fatty alcohol used and the distribution of the propylene glycol block; alternatively, the hydrophilicity is controlled by varying the length and position of the ethylene glycol repeats.

Method of Manufacture

The manufacture of alkyl PEG/PPG ethers consists of a number of variable steps.²⁸ The first step typically involves activating the alkyl alcohol (eg, lauryl alcohol) with a metal hydroxide (eg, potassium hydroxide), thereby generating an alkoxide (eg, lauroxide; ie, the initiator). This alkoxide is then reacted with ethylene oxide, propylene oxide, or a mixture of both (a mixture for random polyalkoxides and consecutively for block polyalkoxides; ie, propagation). The propagation of the poly-alkoxide is then terminated with a Brønsted-Lowry-type acid (eg, hydrochloric acid), or in the case of the dimethyl ethers, a methyl halide (eg, methyl iodide). This synthetic pathway (specifically, the addition of ethoxide) can potentially lead to the generation of some 1,4-dioxane; however, this by-product can be monitored easily by gas chromatography and minimized via suitable process and purification accommodations.

Inclusion of propylene oxide into nonionic surfactants can be accomplished by (1) placement of a single block of propylene oxide between the alcohol and a block of ethylene oxide; (2) by placing a single block of propylene oxide after a single block of ethylene oxide; (3) by direct placement into the polyoxyethylene portion as a propylene oxide block or as an ethylene oxide-propylene oxide mix; or (4) by placing a single propylene oxide block in the middle of the ethylene oxide chain.²⁹ The propylene oxide placement affects the physical and surface active properties.

Impurities

No published impurities data were found, other than one source stating that PPG-25-laureth-25 contains ≤ 10 mg/L 1,4-dioxane.³⁰

It is not expected that there would be any significant amount of the residual starting materials used in the manufacture of the alkyl PEG/PPG ethers (ie, ethylene oxide and propylene oxide) or any significant amount of the residual by-product 1,4-dioxane found in these ingredients. Since these are volatile compounds, any levels present are expected to be low.

Formulators are advised to keep the levels of these starting materials and residual byproducts low. The National Toxicology Program *Report on Carcinogens, Twelfth Edition*, states that ethylene oxide is known to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in

Table 2. Definitions, Structures, and, Functions.

Ingredient (CAS No. if available)	Definition ¹ and structure (CIR 111611)	Function
PEG-4-PPG-7 C13/C15 alcohol	The polyoxypropylene ether of a mixture of synthetic C13/C15 alcohols with an average propoxylation value of 7 and an average ethoxylation value of 4	Surfactant—emulsifying agent
PEG/PPG-3/6 dimethyl ether (61419-46-3)	The copolymer produced by the interaction of 3 mol of ethylene oxide with 6 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-7/12 dimethyl ether	Copolymer produced by the interaction of 7 mol of ethylene oxide with 12 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-9/2 dimethyl ether (61419-46-3)	The copolymer produced by the interaction of 9 mol of ethylene oxide with 2 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-14/7 dimethyl ether (61419-46-3)	The copolymer produced by the interaction of 14 mol of ethylene oxide with 7 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-17/4 dimethyl ether	The copolymer produced by the interaction of 17 mol of ethylene oxide with 4 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-22/40 dimethyl ether	A copolymer produced by the interaction of 22 mol of ethylene oxide with 40 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-27/14 dimethyl ether	A copolymer produced by the interaction of 27 mol of ethylene oxide with 14 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent— miscellaneous
PEG/PPG-35/40 dimethyl ether	The copolymer produced by interacting 35 mol of ethylene oxide with 40 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent— miscellaneous

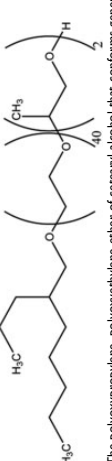
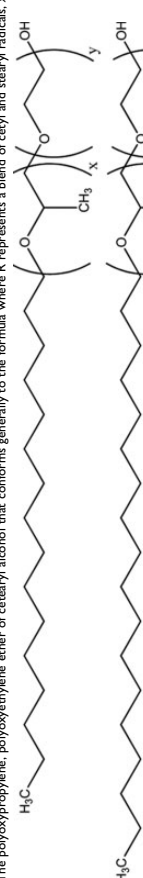
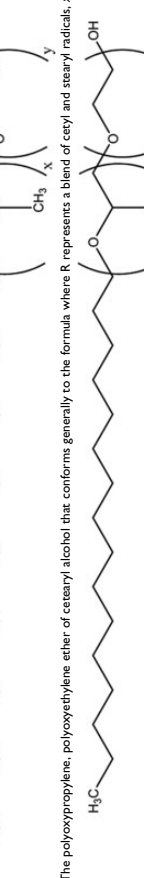
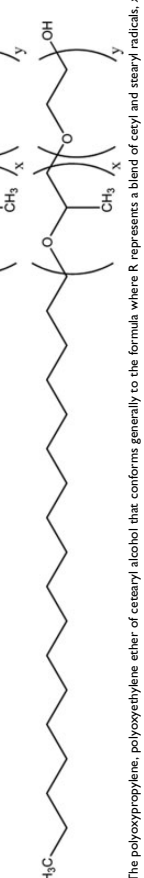
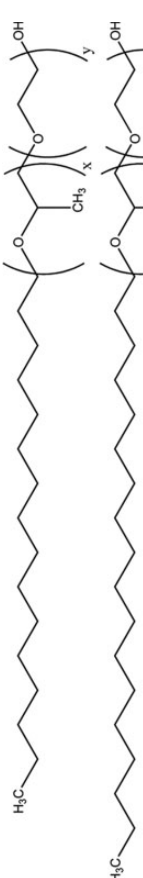
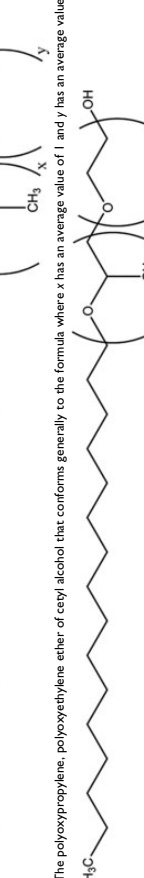
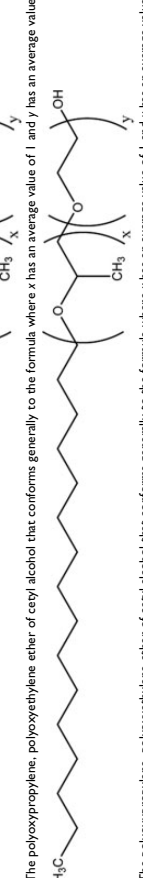
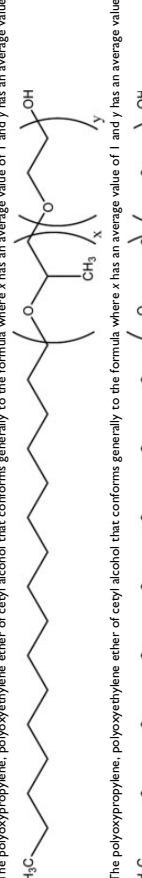
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Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,CR 1126a}	Function
PEG/PPG-36/41 dimethyl ether	The copolymer produced by the interaction of 36 mol of ethylene oxide and 41 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent—miscellaneous
PEG/PPG-50/40 dimethyl ether	The copolymer produced by the interaction of 50 mol of ethylene oxide with 40 mol of propylene oxide end blocked with dimethyl ether	Skin-conditioning agent—miscellaneous
PEG/PPG-52/32 dimethyl ether	A copolymer produced by the interaction of 52 mol of ethylene oxide with 32 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent—miscellaneous
PEG/PPG-55/28 dimethyl ether	A copolymer produced by the interaction of 55 mol of ethylene oxide with 28 mol of propylene oxide end blocked with methyl ether	Skin-conditioning agent—miscellaneous
PEG/PPG-4/2 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 4 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PEG/PPG-6/2 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 6 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PEG-7/PPG-2 propylheptyl ether	The product formed by the reaction of 2-propylheptanol with an average of 7 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PEG/PPG-8/2 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 8 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PEG/PPG-10/2 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 10 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PEG/PPG-14/2 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 14 mol of ethylene oxide and 2 mol of propylene oxide	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent

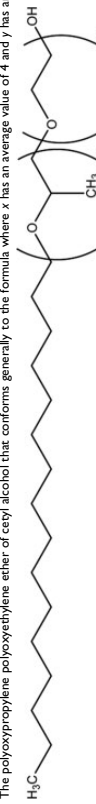
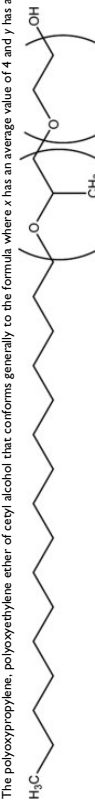
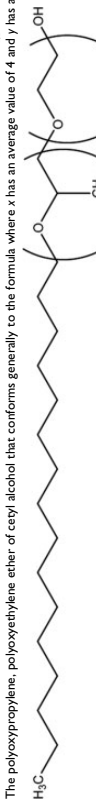
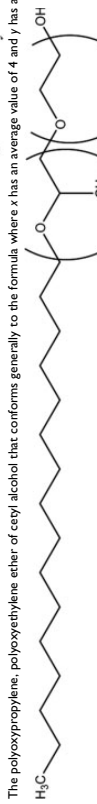
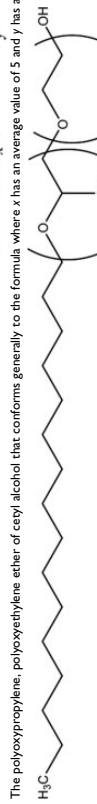
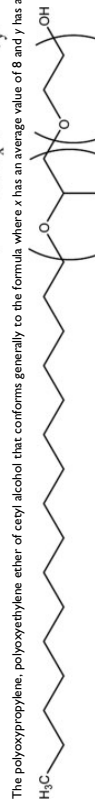
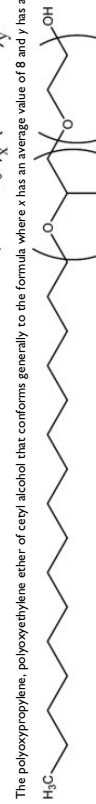
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Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ¹ C18, C18-18	Function
PEG/PPG-402 propylheptyl ether (166736-08-9)	The product formed by the reaction of 2-propylheptanol with an average of 40 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—cleansing, dispersing, emulsifying, or solubilizing agent
PPG-2-ceteareth-9	The polyoxypropylene, polyoxyethylene ether of cetearyl alcohol that conforms generally to the formula where R represents a blend of cetyl and stearyl radicals, x has an average value of 2, and y has an average value of 9 	Surfactant—emulsifying agent
PPG-4-ceteareth-12	The polyoxypropylene, polyoxyethylene ether of cetearyl alcohol that conforms generally to the formula where R represents a blend of cetyl and stearyl radicals, x has an average value of 4, and y has an average value of 12 	Surfactant—emulsifying agent
PPG-10-ceteareth-20	The polyoxypropylene, polyoxyethylene ether of cetearyl alcohol that conforms generally to the formula where R represents a blend of cetyl and stearyl radicals, x has an average value of 10, and y has an average value of 20 	Surfactant—emulsifying agent
PPG-1-ceteeth-5 (37311-01-6; 9087-53-0)	The polyoxypropylene, polyoxyethylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 1 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-1-ceteeth-5 (37311-01-6; 9087-53-0)	The polyoxypropylene, polyoxyethylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 5 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-1-ceteeth-10 (37311-01-6; 9087-53-0)	The polyoxypropylene, polyoxyethylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 10 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-1-ceteeth-20 (37311-01-6; 9087-53-0)	The polyoxypropylene, polyoxyethylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 20 	Skin-conditioning agent—emollient surfactant—emulsifying and solubilizing agent

(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ² (CIR 1334a)	Function
PPG-2-ceteih-1 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 2 and y has an average value of 1 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-2-ceteih-5 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 2 and y has an average value of 5 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-2-ceteih-10 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 2 and y has an average value of 10 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-2-ceteih-20 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 2 and y has an average value of 20 	Skin-conditioning agent—emollient surfactant—emulsifying and solubilizing agent
PPG-4-ceteih-1 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 4 and y has an average value of 1 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-4-ceteih-5 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 4 and y has an average value of 5 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-4-ceteih-10 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 4 and y has an average value of 10 	Surfactant—emulsifying agent
PPG-4-ceteih-20 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 4 and y has an average value of 20 	Surfactant—emulsifying agent
PPG-5-ceteih-20 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 5 and y has an average value of 20 	Surfactant—emulsifying agent
PPG-8-ceteih-1 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 8 and y has an average value of 1 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-8-ceteih-2 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 8 and y has an average value of 2 	Skin-conditioning agent—emollient surfactant—emulsifying agent

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Table 2. (continued)

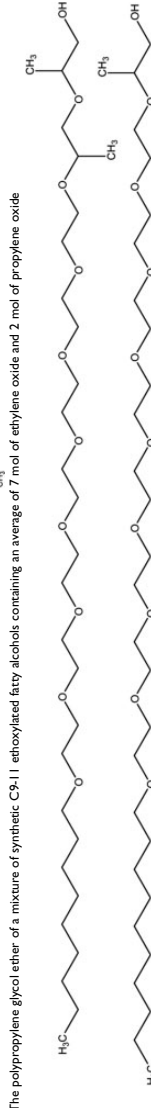
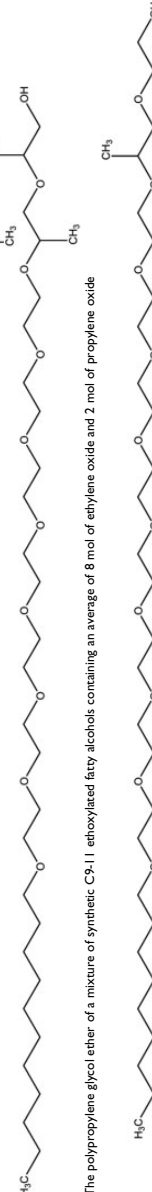
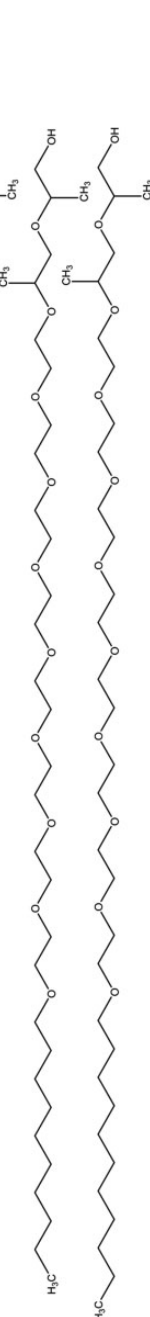
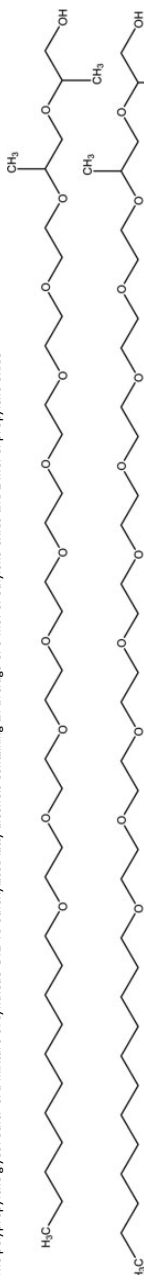
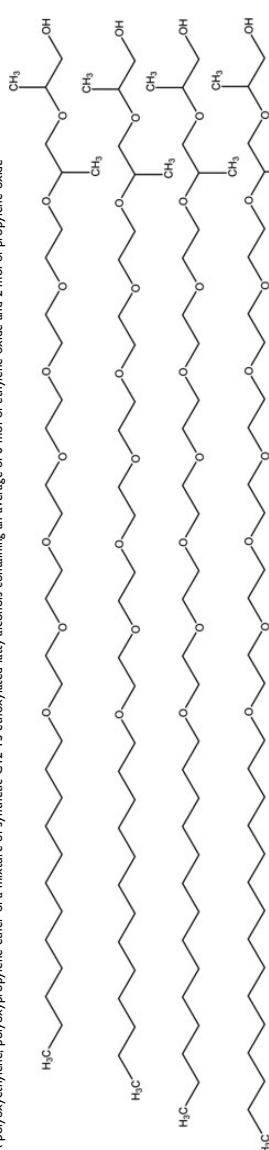
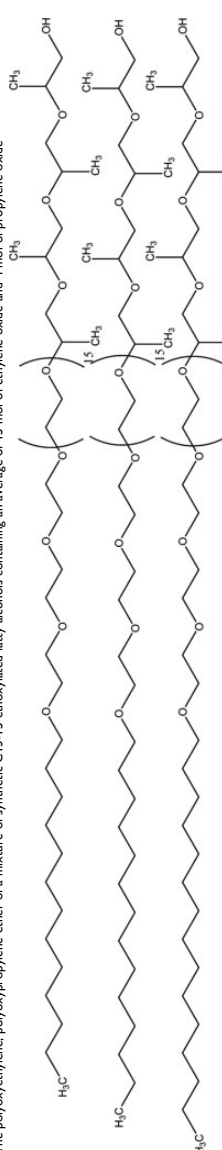
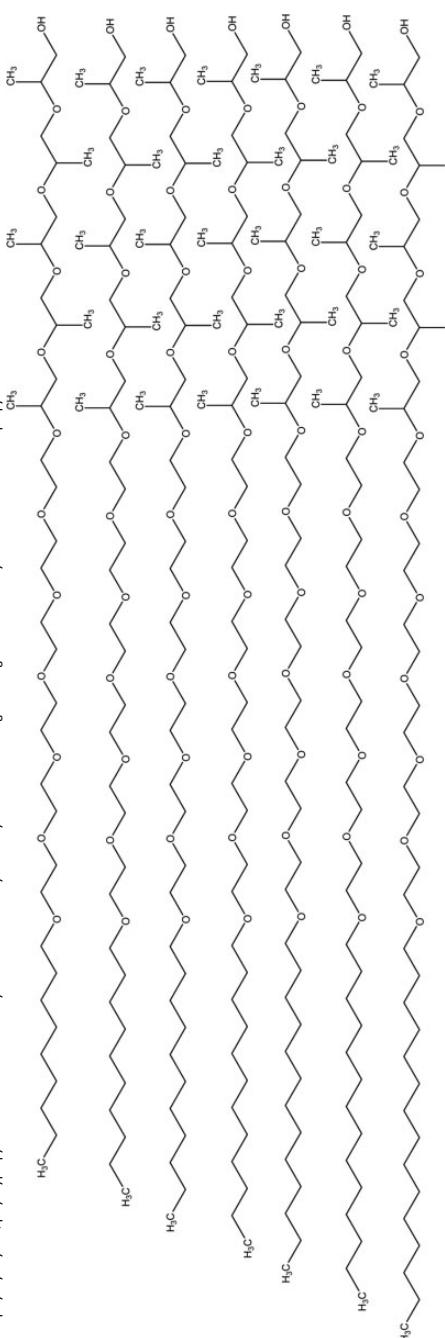
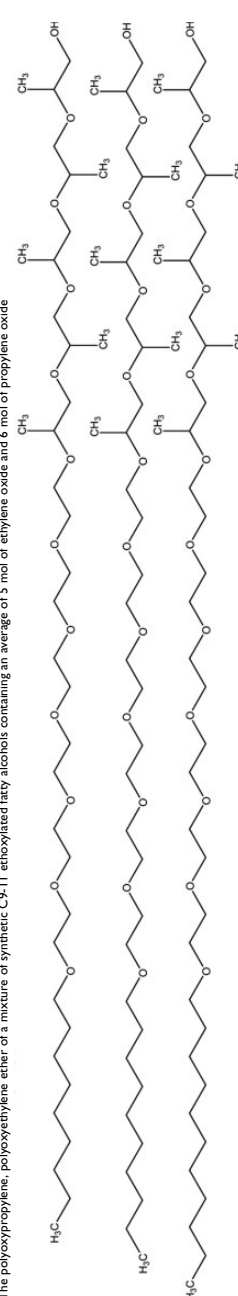
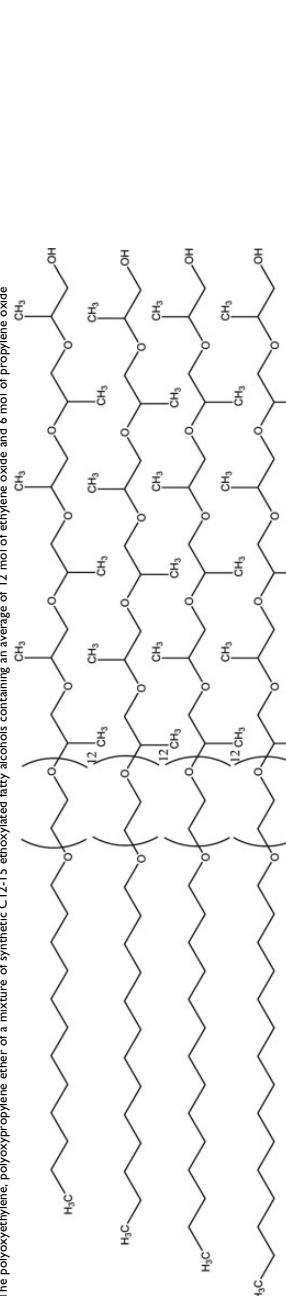
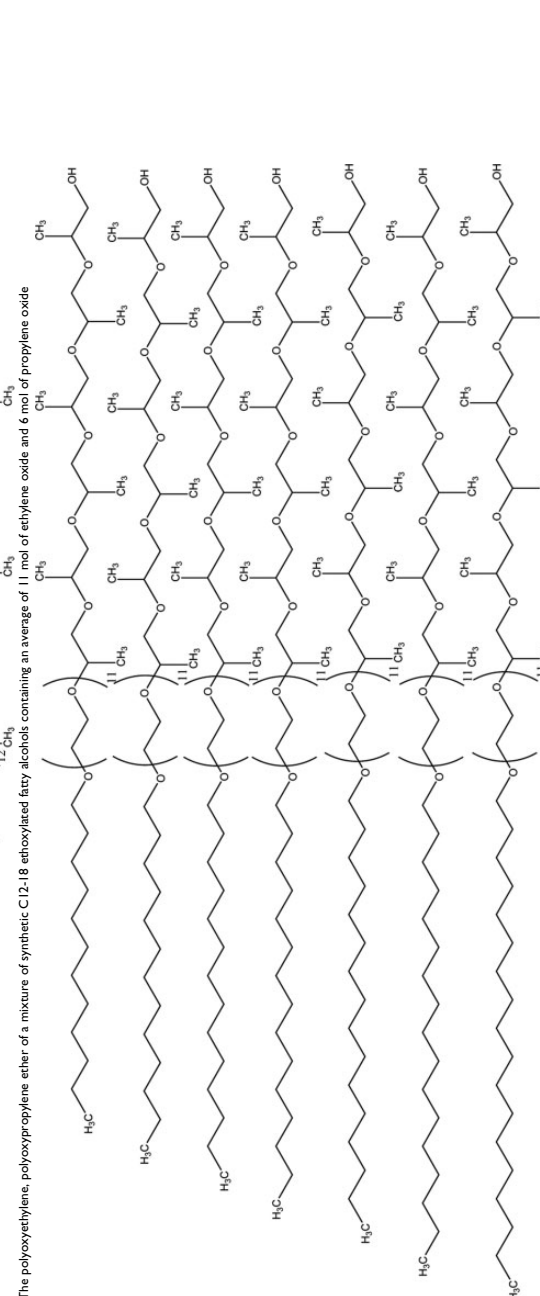
Ingredient (CAS No. if available)	Definition ¹ and structure ¹ C18, 18A, 18B	Function
PPG-8-ceteeth-5 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 8 and y has an average value of 5 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-8-ceteeth-10 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 8 and y has an average value of 10 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-8-ceteeth-20 (37311-01-6; 9087-53-0)	The polyoxypropylene ether of cetyl alcohol that conforms generally to the formula where x has an average value of 8 and y has an average value of 20 	Surfactant—emulsifying agent
PPG-2 C9-11 parenth-5	The polypropylene glycol ether of a mixture of synthetic C9-11 ethoxylated fatty alcohols containing an average of 5 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2 C9-11 parenth-7	The polypropylene glycol ether of a mixture of synthetic C9-11 ethoxylated fatty alcohols containing an average of 7 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2 C9-11 parenth-8	The polypropylene glycol ether of a mixture of synthetic C9-11 ethoxylated fatty alcohols containing an average of 8 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying and cleansing agent
PPG-2 C9-11 parenth-11	The polypropylene glycol ether of a mixture of synthetic C9-11 ethoxylated fatty alcohols containing an average of 11 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying and cleansing agent

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,2,3,4,5,6}	Function
PPG-2 C12-13 parath-8	The polypropylene glycol ether of a mixture of synthetic C12-13 ethoxylated fatty alcohols containing an average of 8 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2 C12-15 parath-6	A polyoxyethylene, polyoxypropylene ether of a mixture of synthetic C12-15 ethoxylated fatty alcohols containing an average of 6 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-4 C13-15 parath-15	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic C13-15 ethoxylated fatty alcohols containing an average of 15 mol of ethylene oxide and 4 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-5 C9-15 parath-6	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic C9-15 ethoxylated fatty alcohols containing an average of 6 mol of ethylene oxide and 5 mol of propylene oxide 	Surfactant—emulsifying agent

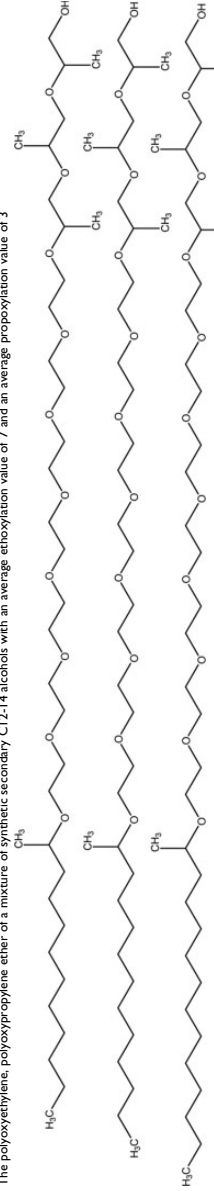
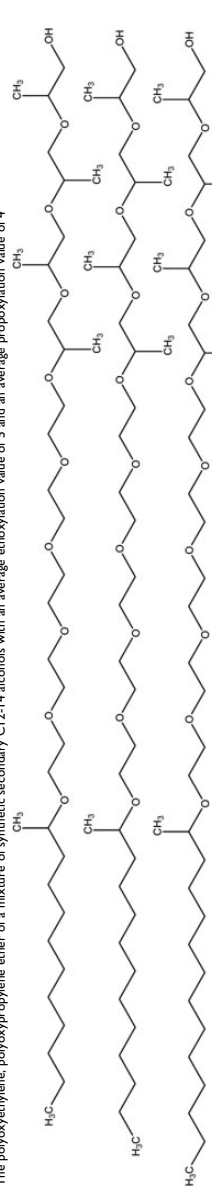
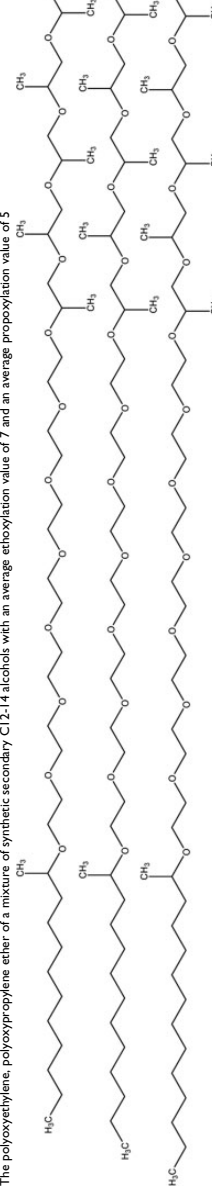
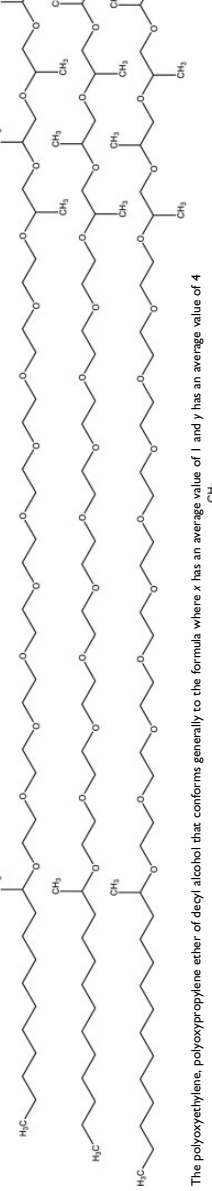
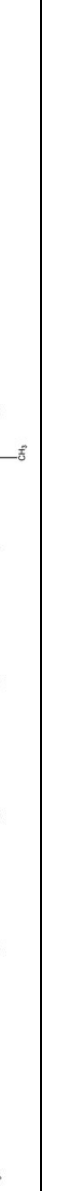
(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1, CH 1541a}	Function
PPG-4 C9-11 parath-5 (154518-36-2)	The polyoxypropylene, polyoxyethylene ether of a mixture of synthetic C9-11 ethoxylated fatty alcohols containing an average of 5 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-4 C12-15 parath-12(68551-13-3) ^{2c}	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic C12-15 ethoxylated fatty alcohols containing an average of 12 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-4 C12-18 parath-11	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic C12-18 ethoxylated fatty alcohols containing an average of 11 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent

(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,2} (CIR 112616)	Function
PPG-3 C12-14 sec-par eth-7 (681 31-40-8) ^{1,2}	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic secondary C12-14 alcohols with an average ethoxylation value of 7 and an average propoxylation value of 3 	Emulsion stabilizer; surfactant—emulsifying agent
PPG-4 C12-14 sec-par eth-5 (681 31-40-8) ^{1,2}	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic secondary C12-14 alcohols with an average ethoxylation value of 5 and an average propoxylation value of 4 	Emulsion stabilizer; surfactant—emulsifying agent
PPG-5 C12-14 sec-par eth-7 (681 31-40-8) ^{1,2}	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic secondary C12-14 alcohols with an average ethoxylation value of 7 and an average propoxylation value of 5 	Emulsion stabilizer; surfactant—emulsifying agent
PPG-9 C12-14 sec-par eth-9 (681 31-40-8) ^{1,2}	The polyoxyethylene, polyoxypropylene ether of a mixture of synthetic secondary C12-14 alcohols with an average ethoxylation value of 9 and an average propoxylation value of 5 	Emulsion stabilizer; surfactant—emulsifying agent
PPG-1-dec eth-4	The polyoxyethylene, polyoxypropylene ether of decyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 4 	Surfactant—cleansing and emulsifying agent
PPG-1-dec eth-5	The polyoxyethylene, polyoxypropylene ether of decyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 5 	Surfactant—cleansing and emulsifying agent
PPG-1-dec eth-6	The polyoxyethylene, polyoxypropylene ether of decyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 6 	Surfactant—emulsifying agent
PPG-1-dec eth-7	The polyoxyethylene, polyoxypropylene ether of decyl alcohol that conforms generally to the formula where x has an average value of 1 and y has an average value of 7 	Surfactant—cleansing and emulsifying agent

(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure (CIR 1141a)	Function
PPG-2-deceth-3 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 3 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-5	The polyoxypropylene ether of decyl alcohol containing an average of 5 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-7 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 7 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-8	The polyoxypropylene ether of decyl alcohol containing an average of 8 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-10 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 10 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-12 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 12 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-15 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 15 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-20 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 20 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-30 (37251-67-5)	The polyoxypropylene ether of decyl alcohol containing an average of 30 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-40	The polyoxypropylene ether of decyl alcohol containing an average of 40 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-50	The polyoxypropylene ether of decyl alcohol containing an average of 50 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-deceth-60	The polyoxypropylene ether of decyl alcohol containing an average of 60 mol of ethylene oxide and 2 mol of propylene oxide 	Surfactant—emulsifying agent

(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,CR,13a,f}	Function
PPG-4-deceth-4	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 4 mol of ethylene oxide and 4 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-4-deceth-6 (37251-67-5)	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 4 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-6-deceth-4 (68154-97-2) ⁵²	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 4 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-6-deceth-9 (68154-97-2) ⁵²	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 9 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-8-deceth-6 (68154-97-2) ⁵²	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 6 mol of ethylene oxide and 8 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-14-deceth-6	The polyoxyethylene, polyoxypropylene ether of decyl alcohol containing an average of 6 mol of ethylene oxide and 14 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-6-decyltetradeceth-12 (72484-69-6) ¹⁵	The polyoxypropylene, polyoxyethylene ether of decyltetradecanol containing an average of 12 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-6-decyltetradeceth-20 (72484-69-6) ¹⁵	The polyoxypropylene, polyoxyethylene ether of decyltetradecanol containing an average of 20 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-6-decyltetradeceth-30 (72484-69-6) ¹⁷	The polyoxypropylene, polyoxyethylene ether of decyltetradecanol containing an average of 30 mol of ethylene oxide and 6 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-13-decyltetradeceth-24	The polyoxypropylene, polyoxyethylene ether of decyltetradecanol containing an average of 24 mol of ethylene oxide and 13 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-20-decyltetradeceth-10	The polyoxypropylene, polyoxyethylene ether of decyltetradecanol containing an average of 10 mol of ethylene oxide and 20 mol of propylene oxide 	Surfactant—emulsifying agent

(continued)

Table 2. (continued)

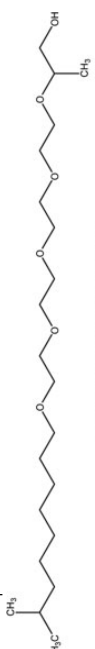
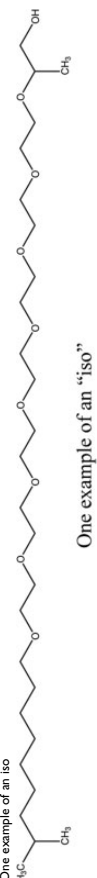
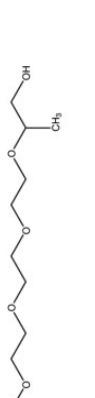
Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,CRK 11545a}	Function
PPG-9-ethylhexeth-5 (64366-70-7)	The polyoxypropylene, polyoxyethylene ether of octyl alcohol containing an average of 5 mol of ethylene oxide and 6 mol of propylene oxide 9	Surfactant—emulsifying agent
PPG-1-isodeceth-4	The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 5 mol of ethylene oxide and 4 mol of propylene oxide 4 (also known as propylene glycol isodeceth-4)⁵¹ One example of an “iso”  One example of an “iso” 	Surfactant—cleansing and emulsifying agent
PPG-1-isodeceth-6	The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 6 mol of ethylene oxide and 6 mol of propylene oxide 1 One example of an iso  One example of an “iso” 	Surfactant—cleansing and emulsifying agent
PPG-1-isodeceth-7	The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 7 mol of ethylene oxide and 6 mol of propylene oxide 1 One example of an iso  One example of an “iso” 	Surfactant—cleansing and emulsifying agent
PPG-1-isodeceth-9	The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 9 mol of ethylene oxide and 6 mol of propylene oxide 1 One example of an iso  One example of an “iso” 	Surfactant—cleansing and emulsifying agent
PPG-2-isodeceth-4 (155683-77-5) ⁵²	One example of an “iso” The polyoxypropylene, polyoxyethylene glycol ether of isodecyl alcohol containing an average of 4 mol of ethylene oxide and 2 mol of propylene oxide 9 One example of an iso  One example of an “iso” 	Surfactant—emulsifying agent
PPG-2-isodeceth-6 (155683-77-5) ⁵²	One example of an “iso” The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 6 mol of ethylene oxide and 6 mol of propylene oxide 2 One example of an iso  One example of an “iso” 	Surfactant—emulsifying agent
PPG-2-isodeceth-8 (155683-77-5) ⁵²	One example of an “iso” The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 8 mol of ethylene oxide and 6 mol of propylene oxide 2 One example of an iso  One example of an “iso” 	Surfactant—cleansing and emulsifying agent
PPG-2-isodeceth-9 (155683-77-5) ⁵²	One example of an “iso” The polyoxyethylene, polyoxypropylene ether of isodecyl alcohol containing an average of 9 mol of ethylene oxide and 6 mol of propylene oxide 2 One example of an iso  One example of an “iso” 	Surfactant—emulsifying agent

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,CRK 1556a}	Function
PPG-3-isododeceth-10 (155683-77-5) ¹²	The polyoxypropylene ether of isododecyl alcohol containing an average of 10 mol of ethylene oxide and 6 mol of propylene oxide One example of an iso	Surfactant—cleansing and emulsifying agent
PPG-3-isododeceth-12 (155683-77-5) ¹²	One example of an “iso” The polyoxypropylene ether of isododecyl alcohol containing an average of 12 mol of ethylene oxide and 6 mol of propylene oxide One example of an iso	Surfactant—emulsifying agent
PPG-3-isododeceth-18 (155683-77-5) ¹²	One example of an “iso” The polyoxypropylene ether of isododecyl alcohol containing an average of 18 mol of ethylene oxide and 6 mol of propylene oxide One example of an iso	Surfactant—cleansing and emulsifying agent
PPG-2-isododeceth-25 (155683-77-5) ¹²	One example of an “iso” The polyoxypropylene ether of isododecyl alcohol containing an average of 25 mol of ethylene oxide and 6 mol of propylene oxide One example of an iso	Surfactant—cleansing and emulsifying agent
PPG-3-isododeceth-1 (155683-77-5) ¹²	One example of an “iso” The polyoxypropylene ether of isododecyl alcohol containing an average of 1 mol of ethylene oxide and 3 mol of propylene oxide One example of an iso	Skin-conditioning agent—emollient
PPG-4-isododeceth-10	One example of an “iso” The polyoxypropylene ether of isododecyl alcohol containing an average of 10 mol of ethylene oxide and 4 mol of propylene oxide One example of an iso	Surfactant—cleansing and emulsifying agent
PPG-3-isosteareth-9	One example of an “iso” The polyoxypropylene ether of isostearyl alcohol containing an average of 9 mol of ethylene oxide and 3 mol of propylene oxide One example of an iso	Surfactant—emulsifying agent
PPG-3-laureth-5	One example of an “iso” The polyoxypropylene ether of lauryl alcohol containing an average of 5 mol of ethylene oxide and 2 mol of propylene oxide One example of an iso	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-3-laureth-8	The polyoxypropylene ether of lauryl alcohol containing an average of 8 mol of ethylene oxide and 2 mol of propylene oxide One example of an iso	Skin-conditioning agent—emollient surfactant—emulsifying agent

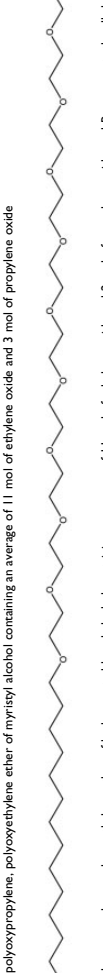
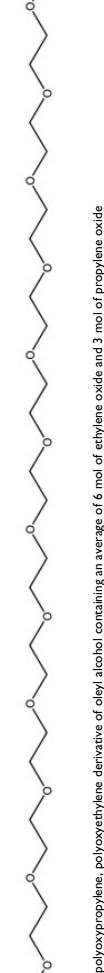
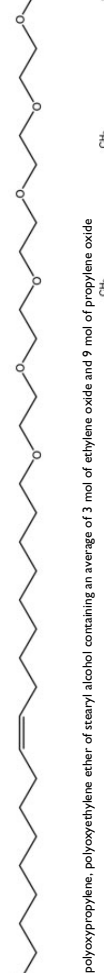
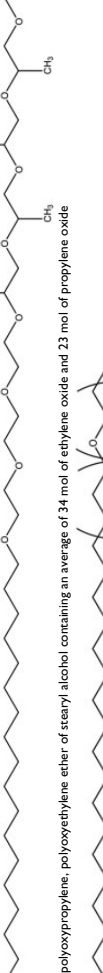
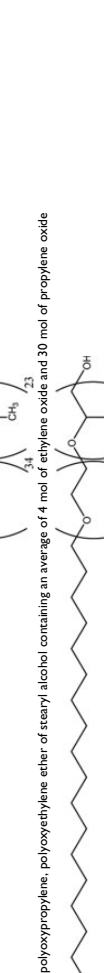
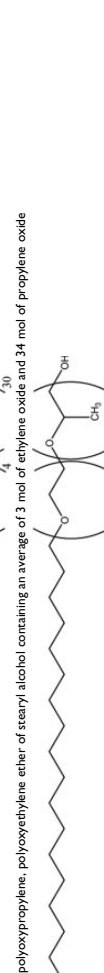
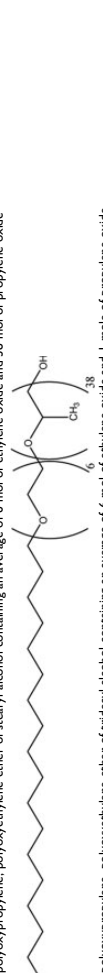
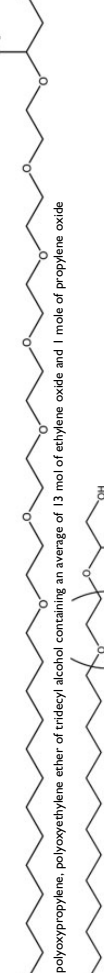
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Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure (CIR 1188a)	Function
PPG-2-laureth-12	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 9 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-3-laureth-8	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 8 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-3-laureth-9	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 9 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-3-laureth-10	The polyoxypropylene, polyoxyethylene derivative of lauryl alcohol containing an average of 10 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-3-laureth-12	The polyoxypropylene, polyoxyethylene derivative of lauryl alcohol containing an average of 12 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-4-laureth-2 (68439-51-0) ⁵²	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 2 mol of ethylene oxide and 4 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-4-laureth-5 (68439-51-0) ⁵²	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 5 mol of ethylene oxide and 4 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-4-laureth-7	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 7 mol of ethylene oxide and 4 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-4-laureth-15	The polyoxypropylene, polyoxypropylene ether of lauryl containing an average of 15 mol of ethylene oxide and 4 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-5-laureth-5	The polyoxypropylene, polyoxypropylene ether of lauryl alcohol containing an average of 5 mol of ethylene oxide and 5 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-6-laureth-3	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 3 mol of ethylene oxide and 6 mol of propylene oxide 	Skin-conditioning agent—emollient surfactant—emulsifying agent
PPG-25-laureth-25 (37311-00-5; 68238-81-3) ⁵²	The polyoxypropylene, polyoxyethylene ether of lauryl alcohol containing an average of 25 mol of ethylene oxide and 25 mol of propylene oxide 	Surfactant—emulsifying agent

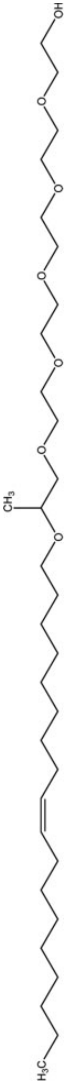
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Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure ^{1,2,3,4,5}	Function
PPG-3-myreth-3 (37311-04-9)	The polyoxypropylene, polyoxyethylene ether of myristyl alcohol containing an average of 3 mol of ethylene oxide and 3 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-3-myreth-11 (37311-04-9)	The polyoxypropylene, polyoxyethylene ether of myristyl alcohol containing an average of 11 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-2-PEG-11 hydrogenated lauryl alcohol ether	A polyoxypropylene, polyoxyethylene ether of hydrogenated lauryl alcohol containing an average of 11 mol of ethylene oxide and 2 mol of propylene oxide, and R represents the alkyl groups derived from hydrogenated lauryl alcohol 	Surfactant—emulsifying agent
PPG-3-PEG-6 oleyl ether	The polyoxypropylene, polyoxyethylene derivative of oleyl alcohol containing an average of 6 mol of ethylene oxide and 3 mol of propylene oxide 	Surfactant—emulsifying agent
PPG-9-steareth-3 (9038-43-1)	The polyoxypropylene, polyoxyethylene ether of stearyl alcohol containing an average of 3 mol of ethylene oxide and 9 mol of propylene oxide 	Skin-conditioning agent—emollient
PPG-23-steareth-34 (9038-43-1)	The polyoxypropylene, polyoxyethylene ether of stearyl alcohol containing an average of 34 mol of ethylene oxide and 23 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-30-steareth-4	The polyoxypropylene, polyoxyethylene ether of stearyl alcohol containing an average of 4 mol of ethylene oxide and 30 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-34-steareth-3	The polyoxypropylene, polyoxyethylene ether of stearyl alcohol containing an average of 3 mol of ethylene oxide and 34 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-38-steareth-6	The polyoxypropylene, polyoxyethylene ether of stearyl alcohol containing an average of 6 mol of ethylene oxide and 38 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-1-rideceth-6	The polyoxypropylene, polyoxyethylene ether of tridecyl alcohol containing an average of 6 mol of ethylene oxide and 1 mole of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-1-rideceth-13	The polyoxypropylene, polyoxyethylene ether of tridecyl alcohol containing an average of 13 mol of ethylene oxide and 1 mole of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent

(continued)

Table 2. (continued)

Ingredient (CAS No. if available)	Definition ¹ and structure (CIR staff ^a)	Function
PPG-4-trideceth-5 (65150-81-4) ⁵²	The polyoxypropylene, polyoxyethylene ether of tridecyl alcohol containing an average of 6 mol of ethylene oxide and 4 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
PPG-6-trideceth-8	The polyoxypropylene, polyoxyethylene ether of tridecyl alcohol containing an average of 8 mol of ethylene oxide and 6 mol of propylene oxide 	Skin-conditioning agent—emollient; surfactant—emulsifying agent
Propylene glycol capreth-4	The propylene glycol ether of a polyethylene glycol derivative of capryl alcohol containing an average of 4 mol of ethylene oxide 	Surfactant—emulsifying agent
Propylene glycol isodeceth-4	The propylene glycol ether of ethoxylated isodecyl alcohol containing an average of 4 mol of ethylene oxide (also known as PPG-1-Isodeceth-4) ⁵³ One example of an iso 	Surfactant—emulsifying agent
Propylene glycol isodeceth-12	One example of an “iso” The propylene glycol ether of ethoxylated isodecyl alcohol containing an average of 4 mol of ethylene oxide One example of an iso 	Surfactant—emulsifying agent
Propylene glycol laureth-6	One example of an “iso” The propylene glycol ether of laureth-6 containing an average of 6 mol of ethylene oxide 	Surfactant—emulsifying agent
Propylene glycol oleth-5	The propylene glycol ether of oleth-5 containing an average of 6 mol of ethylene oxide 	Surfactant—emulsifying agent

Abbreviation: Cosmetic Ingredient Review.
^aCIR staff drew the structures.

Table 3. Physical and Chemical Properties.

Property	Description	Reference
PPG-5 C9-I5 pareth-6		
Physical state and appearance	Colorless to yellowish liquid	25
Active content	100%	25
Solubility	Soluble in water	25
Stability	Stable in acid and alkali	25
PPG-3 C12-I4 sec-pareth-7		
Odor	Odorless	12
Specific gravity	0.969 (20°C/20°C)	12
Stability	Stable to both acid and alkali; do not react with water or air under normal conditions	12
PPG-4 C12-I4 sec-pareth-5		
Odor	Odorless	12
Specific gravity	0.956 (20°C/20°C)	12
Stability	Stable to both acid and alkali; do not react with water or air under normal conditions	12
PPG-5 C12-I4 sec-pareth-7		
Odor	Odorless	12
Specific gravity	0.975 (20°C/20°C)	12
Stability	Stable to both acid and alkali; do not react with water or air under normal conditions	12
PPG-5 C12-I4 sec-pareth-9		
Odor	Odorless	12
Specific gravity	0.979 (20°C/20°C)	12
Stability	Stable to both acid and alkali; do not react with water or air under normal conditions	12
PPG-2 C12-I5 pareth-6		
Physical state	Liquid	14
Active content	100% by wt	14
PPG-4-ceteth-1		
Physical state and appearance	Colorless to pale yellow liquid	7
PPG-4-ceteth-10		
Physical state and appearance	Colorless liquid; colorless to pale yellow petrolatum-like substance	19,8
PPG-4-ceteth-20		
Physical state and appearance	White solid; colorless to pale yellow waxy substance	20,9
PPG-5-ceteth-20		
Physical state	liquid; clear to slightly hazy liquid	11,21
Boiling point	310.9°C (760 mm Hg)	6
Solubility	Soluble in water and isopropanol; dispersible in mineral oil	11
PPG-8-ceteth-1		
Physical state and appearance	Colorless liquid	22
PPG-8-ceteth-20		
Physical state and appearance	Yellow solid	23
PPG-2-deceth-3		
Physical state and appearance	Slightly yellow oil	13
PPG-2-deceth-5		
Physical state and appearance	Slightly yellow oil	13
PPG-2-deceth-7		
Physical state and appearance	Slightly yellow turbid oil	13
PPG-2-deceth-8		
Physical state and appearance	Clear liquid	5
Active content	90% (water content; 10%)	5
Density	1,020 kg/m ³ (20°C)	5
Solubility	Soluble in water, ethanol, propylene glycol, and 2-propanol; dispersible in low aromatic solvent, white spirit, and xylene	5
PPG-2-deceth-10		
Physical state and appearance	Slightly yellow soft paste	13
PPG-2-deceth-12		
Physical state and appearance	Slightly yellow soft paste	13
PPG-2-deceth-15		
Physical state and appearance	Slightly yellow soft wax	13

(continued)

Table 3. (continued)

Property	Description	Reference
PPG-2-deceth-20		
Physical state and appearance	Slightly yellow soft wax	13
PPG-2-deceth-30		
Physical state and appearance	Slightly yellow soft wax	13
PPG-6-deceth-4		
Physical state	Liquid	14
Active content	100% by wt	14
PPG-6-deceth-9		
Physical state	Liquid	14
Active content	100% by wt	14
PPG-8-deceth-6		
Physical state	Liquid	14
Active content	100% by wt	14
PPG-6 decyltetradeceth-12		
Physical state and appearance	Yellow solid	15
PPG-6-decyltetradeceth-20		
Physical state and appearance	Yellow solid	16
PPG-6-decyltetradeceth-30		
Physical state and appearance	Yellow solid	17
PPG-9-ethylhexeth-5		
Physical state and appearance	Colorless to yellow liquid with a mild odor	10
Boiling point	Decomposes prior to boiling	10
PPG-3-isodeceth-1		
Physical state	Liquid	18
PPG-4-laureth-2		
Physical state	Liquid	14
Active content	100%	14
PPG-4-laureth-5		
Physical state	Liquid	14
Active content	100%	14
PPG-25-laureth-25		
Physical state and appearance	Colorless or pale yellow liquid; colorless or straw-colored clear liquid	24,30
Solubility	Soluble in water	24
Density	1.046% $\pm$ 2%	30
pH	6.8 $\pm$ 0.4	30
PPG-1-trideceth-13		
Physical state and appearance	Colorless liquid	26
Active content	95%	26
Solubility	Soluble in water	26
Propylene glycol oleth-5		
Physical state	Liquid	14
Active content	100%	14

humans, including epidemiological studies and studies on mechanisms of carcinogenesis,³¹ and that propylene oxide and 1,4-dioxane are reasonably anticipated to be human carcinogens based on sufficient evidence of carcinogenicity from studies in experimental animals.^{32,33} The International Agency for Research on Cancer (IARC) concluded there is limited evidence in humans and sufficient evidence in experimental animals for the carcinogenicity of ethylene oxide, with an overall evaluation that ethylene oxide is carcinogenic to humans.³⁴ For propylene oxide and 1,4-dioxane, the IARC concluded there is inadequate evidence in humans, and there is sufficient evidence in experimental animals for carcinogenicity, with an overall evaluation that propylene oxide is possibly carcinogenic to humans.^{34,35}

Use

Cosmetic

The alkyl PEG/PPG ethers included in this review are reported to function in cosmetics mostly as surfactants, skin-conditioning agents, and/or emulsifying agents.¹ The function(s) of each ingredient are provided in Table 2.

The Food and Drug Administration (FDA) collects information from manufacturers on the use of individual ingredients in cosmetic formulations as a function of cosmetic product category in its Voluntary Cosmetic Registration Program (VCRP). The VCRP data obtained from the FDA in 2013³⁶ and data received in response to a survey of the maximum reported use concentration by category conducted by

the Personal Care Products Council (Council)^{37,38} indicate that 26 of the 131 alkyl PEG/PPG ethers named in this safety assessment are currently used in cosmetic formulations; additionally, according to VCRP data, PPG-30-decyltetradeceth-10, an ingredient not named in the *International Cosmetic Ingredient Dictionary and Handbook*, has one reported use. PPG-5-ceteth-20 has the most reported uses (445), followed by and PEG/PPG-36/41 dimethyl ether (243 reported uses) and PPG-1-trideceth-6 (224 reported uses). All other in-use ingredients have less than 40 reported uses (Table 4).

According to the results of the concentration of use survey, PPG-5-ceteth-20 and PEG/PPG-14/7 dimethyl ether have the highest reported concentrations of use in leave-on formulations; PPG-5-ceteth-20 is used at up to 10% in "other" fragrance preparations and in tonics, dressings, and other hair grooming aids, and PEG/PPG-14/7 dimethyl ether is used at up to 7% in face and neck products and body and hand products. PPG-2-isodeceth-12 has the highest use concentration in rinse-off products; it is used at up to 10% in paste masks and mud packs. All other in-use alkyl PEG/PPG ethers are reported to be used in leave-on products at concentrations of 5% or below (Table 4). The 105 alkyl PEG/PPG ethers not reported to be in use are listed in Table 5.

In some cases, reports of uses were received in the VCRP, but no concentration of use data are available. For example, PPG-2-ceteth-9 is reported to be used in 9 cosmetic formulations, but no concentration of use data were reported. Additionally, for some ingredients, no reported uses were received in the VCRP, but a use concentration was provided in the industry survey. For example, PEG/PPG-55/28 dimethyl ether was not reported to be in use in the VCRP, but the industry survey indicated that it is used at up to 5% in shampoos and other noncoloring hair preparations and at 3% in face and neck formulations. It should be presumed in these cases that there is at least one use in every category for which a concentration is reported.

Some alkyl PEG/PPG ethers are reported to be used in products that are applied to baby skin (eg, PPG-25-laureth-25 has one reported use in other baby products), to the eye area, or to the mucous membranes (eg, PEG/PPG-14/7 dimethyl ether is used in eye lotions at 5%) or that could possibly be ingested (eg, PEG/PPG-36/41 dimethyl ether is used at 5% in lipsticks). Additionally, some of the alkyl esters are used in cosmetic sprays and could possibly be inhaled; the maximum reported use in spray formulation is 7% PEG/PPG-14/7 dimethyl ether in spray body and hand products. In practice, 95% to 99% of the droplets/particles released from cosmetic sprays have aerodynamic equivalent diameters $>10\ \mu\text{m}$, with propellant sprays yielding a greater fraction of droplets/particles $<10\ \mu\text{m}$ compared with pump sprays.^{39,40} Therefore, most droplets/particles incidentally inhaled from cosmetic sprays would be deposited in the nasopharyngeal and thoracic regions of the respiratory tract and would not be respirable (ie, they would not enter the lungs) to any appreciable amount.^{41,42}

Some of the alkyl PEG/PPG ethers are used in spray deodorant products at low concentrations of use; the highest reported use concentration of this type was 0.19% PPG-8-

ceteth-20.³⁷ There is some evidence indicating that deodorant spray products can release substantially larger fractions of particulates having aerodynamic equivalent diameters in the range considered to be respirable.⁴² However, the information is not sufficient to determine whether significantly greater lung exposures result from the use of deodorant sprays compared to other cosmetic sprays.

All of the alkyl PEG/PPG ethers included in this report appear in the European Commission database with information on Cosmetic Ingredients and Substances (CosIng) inventory.⁴³ Listing in the inventory does not indicate the ingredients are actually used in cosmetic products or approved for such use.

Noncosmetic

In Europe, PPG-4-trideceth-6 can be used at 0.05 mg/kg in food contact materials; it is to be used only in polytetrafluoroethylene (PTFE) items sintered at high temperatures (PTFE is the nonstick coating used on cookware).^{44,45}

The inclusion of PPG-5-ceteth-20 in the development of dermal⁴⁶ and nasal⁴⁷ drug delivery systems is being evaluated.⁴⁶ In both studies, systems composed of PPG-5-ceteth-20, oleic acid, and water were used to form thermodynamically stable microemulsions that could phase into a liquid crystalline matrix. Other examples of noncosmetic industrial uses are provided in Table 6.^{5,12,25}

Toxicokinetics

Published absorption, distribution, metabolism, and excretion data were not found. However, data on analogous compounds are available from the previous safety assessments of the alkyl PEG ethers and PPGs. These data suggest that alkyl PEG ethers are readily absorbed through the skin and mucosa of test animals and are quickly eliminated from the body through the urine, feces, and expired air. Dermal metabolism studies of laureth-1 and laureth-10 solutions indicate that in hairless mice, the 4-hour percutaneous absorption decreased from 22.9% for laureth-1 to 2.1% for laureth-10 solutions, 0.25% in ethanol. Compounds analogous to laureth-9 readily penetrated the skin of rats, and approximately 50% of the absorbed dose was excreted. Using humans, the majority of the dose could be wiped away from the test site after 8 hours; less than 2% was found in the urine. With atopic patients, the calculated dermal absorption rate for laureth-9 was 0.0017% for a diluted bath oil and 0.0035% with after-shower application. For PEG-3 methyl ether, however, in vitro absorption data indicated that it would not readily penetrate the skin.² Similarly, previous studies using PPG indicated that PPGs are readily absorbed from the gastrointestinal tract and excreted in the urine and feces.

Dermal penetration of propylene glycol from a ternary cosolvent solution through hairless mouse skin was 57% over a 24-hour period. However, in a study in which propylene glycol was applied to the finger tip of a human, the results of thermal emission decay-Fourier transform infrared spectroscopy indicated that propylene glycol did not reach the dermis.

Table 4. Frequency and Concentration of Use According to Duration and Type of Exposure.

	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷
PEG/PPG-9/2 dimethyl ether						
Total ^a	NR	0.01-2	35	0.00011-7	11	0.1-5
PEG/PPG-14/7 dimethyl ether						
Duration of use						
Leave-on	NR	0.01-2	34	0.00011-7	11	0.1-5
Rinse-off	NR	0.03-0.97	1	0.01-3	NR	NR
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
PEG/PPG-17/4 dimethyl ether						
Exposure type						
Eye area	NR	0.01	NR	0.01-5	NR	3
Incidental ingestion	NR	NR	NR	1	NR	NR
Incidental inhalation—spray	NR	0.05	1 ^b	0.12-7	NR	NR
Incidental inhalation—powder	NR	NR	NR	0.01	NR	NR
Dermal contact	NR	0.01-1	35	0.01-7	11	0.1-5
Deodorant (underarm)	NR	NR	NR	NR	NR	NR
Hair—noncoloring	NR	0.03-2	NR	0.12-3	NR	NR
Hair coloring	NR	NR	NR	0.5	NR	NR
Nail	NR	NR	NR	0.00011-1	NR	NR
Mucous membrane	NR	NR	NR	1	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
PEG/PPG-35/40 dimethyl ether						
Total ^a	NR	1-3	243	0.1-5	2	0.05-2
PEG/PPG-36/41 dimethyl ether						
Duration of use						
Leave-on	NR	1-3	243	0.1-5	NR	0.05
Rinse off	NR	3	NR	0.1-1	2	0.4-2
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
PEG/PPG-50/40 dimethyl ether						
Exposure type						
Eye area	NR	NR	91	0.1-1	NR	0.4
Incidental ingestion	NR	NR	27	5	NR	NR
Incidental inhalation—spray	NR	NR	NR	NR	NR	NR
Incidental inhalation—powder	NR	NR	6	0.1	NR	NR
Dermal contact	NR	1-3	215	0.1-1	2	0.5-2
Deodorant (underarm)	NR	NR	NR	NR	NR	NR
Hair—noncoloring	NR	NR	NR	1	NR	NR
Hair—coloring	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR
Mucous membrane	NR	NR	27	5	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
PEG/PPG-55/28 dimethyl ether						
Total ^a	NR	0.05-5	9	NR	1	NR
PPG-2-ceteareth-9						
Duration of use						
Leave-on	NR	0.5-5	5	NR	1	NR
Rinse-off	NR	0.05-5	4	NR	NR	NR
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
PPG-2-ceteth-10						
Exposure type						
Eye area	NR	NR	NR	NR	NR	NR
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	NR	NR	NR	NR
Incidental inhalation—powder	NR	NR	NR	NR	NR	NR
Dermal contact	NR	0.5-3	8	NR	1	NR
Deodorant (underarm)	NR	NR	NR	NR	NR	NR
Hair—noncoloring	NR	0.05-5	1	NR	NR	NR
Hair—coloring	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR

(continued)

Table 4. (continued)

	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷
Mucous membrane	NR	NR	NR	NR	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-4-ceteth-20		PPG-5-ceteth-20		PPG-8-ceteth-1	
Total	2	NR	445	0.05-10	NR	0.01
Duration of use						
Leave-on	2	NR	217	0.05-10	NR	0.01
Rinse off	NR	NR	202	0.5-9	NR	NR
Diluted for (bath) use	NR	NR	26	1.5	NR	NR
Exposure type						
Eye area	NR	NR	5	0.05-0.81	NR	NR
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	28 ^{b,c}	0.14-5; 1.5-10 ^c	NR	NR
Incidental inhalation—powder	NR	NR	NR	NR	NR	NR
Dermal contact	2	NR	195	0.05-9	NR	0.01
Deodorant (underarm)	NR	NR	4 ^c	3-5	NR	NR
Hair—noncoloring	NR	NR	240	0.14-10	NR	NR
Hair—coloring	NR	NR	8	2-3.1	NR	NR
Nail	NR	NR	2	0.1-1.5	NR	NR
Mucous membrane	NR	NR	73	1.5-9	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-8-ceteth-10		PPG-8-ceteth-20		PPG-2-deceth-3	
Total ^a	NR	0.036	10	0.072-2	NR	0.4
Duration of use						
Leave-on	NR	NR	9	0.1-1.1	NR	0.4
Rinse-off	NR	0.036	1	0.072-2	NR	NR
Diluted for (bath) use	NR	NR	NR	0.075	NR	NR
Exposure type						
Eye area	NR	NR	NR	0.3	NR	0.4
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	NR	0.19; 0.7 ^b	NR	NR
Incidental inhalation—powder	NR	NR	NR	1.1	NR	NR
Dermal contact	NR	NR	10	0.075-2	NR	NR
Deodorant (underarm)	NR	NR	NR	Spray: 0.19; not spray: 1	NR	NR
Hair—noncoloring	NR	0.036	NR	0.075-1	NR	NR
Hair—coloring	NR	NR	NR	0.05	NR	NR
Nail	NR	NR	NR	NR	NR	NR
Mucous membrane	NR	NR	NR	0.075	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-2-deceth-12		PPG-6-decyltetradeceth-20		PPG-6-decyltetradeceth-30	
Total ^a	1	0.24-3	2	NR	18	0.25-2
Duration of use						
Leave-on	NR	0.24-3	2	NR	15	0.25-2
Rinse-off	1	NR	NR	NR	3	0.3-0.5
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
Exposure type						
Eye area	NR	0.24	NR	NR	NR	NR
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	NR	NR	1 ^b	NR
Incidental inhalation—powder	NR	NR	NR	NR	NR	NR
Dermal contact	NR	NR	2	NR	18	0.25-2
Deodorant (underarm)	NR	NR	NR	NR	NR	NR

(continued)

Table 4. (continued)

	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷
Hair—noncoloring	NR	3	NR	NR	NR	NR
Hair—coloring	1	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR
Mucous membrane	NR	NR	NR	NR	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-13-decyltetradeceth-24		PPG-20-decyltetradeceth-10		PPG-30-decyltetradeceth-10 ^d	
Total	37	0.03	2	0.1-2	1	NR
Duration of use						
Leave-on	34	0.03-2	2	0.1-2	NR	NR
Rinse-off	3	0.3-1	NR	1	1	NR
Diluted for (bath) use	NR	2	NR	NR	NR	NR
Exposure type						
Eye area	NR	0.1-0.3	NR	NR	NR	NR
Incidental ingestion	NR	NR	NR	2	NR	NR
Incidental inhalation—spray	1 ^b	0.075-0.9; 2 ^c	NR	0.1-0.3	NR	NR
Incidental inhalation—powder	NR	0.03	NR	NR	NR	NR
Dermal contact	37	0.03-2	1	0.1-2	1	NR
Deodorant (underarm)	NR	Spray: 0.17; not spray: 0.057	NR	Spray: 0.18; not spray: 0.4	NR	NR
Hair—noncoloring	NR	0.3-0.9	1	0.3-1	NR	NR
Hair—coloring	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR
Mucous membrane	NR	2	NR	2	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-2-isodeceth-12		PPG-3-isosteareth-9		PPG-5-laureth-5	
Total	4	0.5-10	3	NR	8	0.033
Duration of use						
Leave-on	2	0.5-1.5	3	NR	5	0.033
Rinse-off	2	10	NR	NR	3	NR
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
Exposure type						
Eye area	NR	NR	NR	NR	NR	NR
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	2 ^c	NR	NR	NR
Incidental inhalation—powder	NR	NR	NR	NR	NR	NR
Dermal contact	2	0.5-10	3	NR	7	0.033
Deodorant (underarm)	NR	NR	NR	NR	2 ^c	NR
Hair—noncoloring	2	1.5	NR	NR	1	NR
Hair—coloring	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR
Mucous membrane	NR	NR	NR	NR	NR	NR
Baby products	NR	NR	NR	NR	NR	NR
	PPG-25-laureth-25		PPG-34-steareth-3		PPG-1-trideceth-6	
Total	31	0.4-2	NR	1.9	224	0.024-0.4
Duration of use						
Leave-on	27	0.4-2	NR	NR	127	0.05-0.4
Rinse-off	4	NR	NR	1.9	97	0.024-0.3
Diluted for (bath) use	NR	NR	NR	NR	NR	NR
Exposure type						
Eye area	2	0.72-1.5	NR	NR	1	NR
Incidental ingestion	NR	NR	NR	NR	NR	NR
Incidental inhalation—spray	NR	NR	NR	NR	1 ^b	0.05

(continued)

Table 4. (continued)

	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷	No. of uses ³⁶	Max concentration of use (%) ³⁷
Incidental inhalation—powder	NR	NR	NR	NR	NR	NR
Dermal contact	29	0.4-2	NR	NR	38	0.2-0.27
Deodorant (underarm)	NR	NR	NR	NR	NR	NR
Hair—noncoloring	2	NR	NR	1.9	168	0.05-0.4
Hair—coloring	NR	NR	NR	NR	11	0.024-0.25
Nail	NR	NR	NR	NR	5	NR
Mucous membrane	1	NR	NR	NR	NR	NR
Baby products	1	NR	NR	NR	NR	NR

Abbreviations: NR, none reported; VCRP, Voluntary Cosmetic Registration Program.

^aBecause each ingredient may be used in cosmetics with multiple exposure types, the sum of all exposure types may not equal the sum of total uses.

^bIncludes suntan products in that it is not known whether the reported product is a spray.

^cIncludes products in that it is not known whether the product is a spray.

^dIncluded in the VCRP but not listed in the *International Cosmetic Ingredient Dictionary and Handbook*.

Table 5. No Reported Use.³⁶⁻³⁸

PEG-4-PPG-7 C13/C15 alcohol	PPG-6 C9-11 pareth-5	PPG-2-isodeceth-8
PEG/PPG-3/6 dimethyl ether	PPG-6 C12-15 pareth-12	PPG-2-isodeceth-9
PEG/PPG-7/12 dimethyl ether	PPG-6 C12-18 pareth-11	PPG-2-isodeceth-10
PEG/PPG-22/40 dimethyl ether	PPG-3 C12-14 sec-pareth-7	PPG-2-isodeceth-18
PEG/PPG-27/14 dimethyl ether	PPG-4 C12-14 sec-pareth-5	PPG-2-isodeceth-25
PEG/PPG-52/32 dimethyl ether	PPG-5 C12-14 sec-pareth-7	PPG-3-isodeceth-1
PEG/PPG-4/2 propylheptyl ether	PPG-5 C12-14 sec-pareth-9	PPG-4-isodeceth-10
PEG/PPG-6/2 propylheptyl ether	PPG-1-deceth-4	PPG-2-laureth-5
PEG-7/PPG-2 propylheptyl ether	PPG-1-deceth-5	PPG-2-laureth-8
PEG/PPG-8/2 propylheptyl ether	PPG-1-deceth-6	PPG-2-laureth-12
PEG/PPG-10/2 propylheptyl ether	PPG-1-deceth-7	PPG-3-laureth-8
PEG/PPG-14/2 propylheptyl ether	PPG-2-deceth-5	PPG-3-laureth-9
PEG/PPG-40/2 propylheptyl ether	PPG-2-deceth-7	PPG-3-laureth-10
PPG-4-cetareth-12	PPG-2-deceth-8	PPG-3-laureth-12
PPG-10-cetareth-20	PPG-2-deceth-10	PPG-4-laureth-2
PPG-1-ceteth-1	PPG-2-deceth-15	PPG-4-laureth-5
PPG-1-ceteth-5	PPG-2-deceth-20	PPG-4-laureth-7
PPG-1-ceteth-10	PPG-2-deceth-30	PPG-4-laureth-15
PPG-1-ceteth-20	PPG-2-deceth-40	PPG-6-laureth-3
PPG-2-ceteth-1	PPG-2-deceth-50	PPG-3-myreth-3
PPG-2-ceteth-5	PPG-2-deceth-60	PPG-3-myreth-11
PPG-2-ceteth-20	PPG-4-deceth-4	PPG-2-PEG-11 hydrogenated lauryl alcohol ether
PPG-4-ceteth-1	PPG-4-deceth-6	PPG-3-PEG-6 oleyl ether
PPG-4-ceteth-5	PPG-6-deceth-4	PPG-9-steareth-3
PPG-4-ceteth-10	PPG-6-deceth-9	PPG-23-steareth-34
PPG-8-ceteth-2	PPG-8-deceth-6	PPG-30 steareth-4
PPG-8-ceteth-5	PPG-14-deceth-6	PPG-38 steareth-6
PPG-2 C9-11-pareth-5	PPG-6-decyltetradeceth-12	PPG-1 trideceth-13
PPG-2 C9-11-pareth-7	PPG-9-ethylhexeth-5	PPG-4 trideceth-6
PPG-2 C9-11 pareth-8	PPG-1-isodeceth-4	PPG-6 trideceth-8
PPG-2 C9-11 pareth-11	PPG-1-isodeceth-6	Propylene glycol capreth-4
PPG-2 C12-13 pareth-8	PPG-1-isodeceth-7	Propylene glycol isodeceth-4
PPG-2 C12-15 pareth-6	PPG-1-isodeceth-9	Propylene glycol isodeceth-12
PPG-4 C13-15 pareth-15	PPG-2-isodeceth-4	Propylene glycol laureth-6
PPG-5 C9-15 pareth-6	PPG-2-isodeceth-6	Propylene glycol oleth-5

Penetration Enhancement

PPG-4-ceteth-20 did not enhance the penetration of tenoxicam, a nonsteroidal anti-inflammatory drug, through guinea pig skin.⁴⁸ An in vitro study was performed in which the permeation through guinea pig skin of a 1.0% tenoxicam suspension

containing 10% propylene glycol and 5.0% PPG-4-ceteth-20 was compared to that of tenoxicam without the surfactant. One gram of the test material was applied to the skin sample, and the receptor fluid was sampled every 3 hours for 48 hours. The steady-state flux was $8.11 \pm 0.56 \times 10^{-5} \mu\text{g/s}\cdot\text{cm}^2$ for

Table 6. Examples of Noncosmetic Uses.

Ingredient	Use	Reference
PPG-5 C9-15 pareth-6	Industrial washer and cleansing agents	25
PPG C12-14 sec-pareth	Nonionic surfactants in the paper and pulp, metal, textile, plastics and paint, pesticide, and leather and fur industries	12
PPG-2-deceth-8	All-purpose cleaner and emulsifier in paints and coatings	5

tenoxicam without surfactant and $7.28 \pm 0.94 \times 10^{-5} \mu\text{g/s}\cdot\text{cm}^2$ for tenoxicam with PPG-4-ceteth-20; penetration rates were not statistically significantly different.

Toxicological Studies

Published toxicity studies were not found. However, data on analogous compounds are available from previous safety assessments of the alkyl PEG ethers and PPGs.^{2,3,5}

Reproductive and Developmental Toxicity

No published reproductive and developmental toxicity studies were found. However, data on analogous compounds are available from the safety assessments of the alkyl PEG ethers and PPGs.

Genotoxicity

No published genotoxicity studies were found. However, data on analogous compounds are available from the safety assessments of the alkyl PEG ethers, and PPGs show that these compounds were not mutagenic or genotoxic.

Carcinogenicity

No published carcinogenicity studies were found. Studies from previously reviewed ingredients indicate that compounds analogous to laureth-9 were not carcinogenic to rats, and propylene glycol was not carcinogenic in mice (lifetime dermal study) or in rats (2-year chronic feed study).

Irritation and Sensitization

Nonhuman

PPG-5-ceteth-20 was classified as a moderate-to-mild dermal irritant in an *in vitro* assay.⁴⁹ In a 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) cytotoxicity assay performed to predict dermal irritancy, PPG-5-ceteth-20 had an ET_{50} (ie, time required to reduce tissue viability by 50%) of 9.78 hours; substances with an ET_{50} in the range of 4 to 12 hours have an expected irritancy of moderate to mild.

A single 24-hour occlusive application of PPG-5-ceteth-20 was not a primary dermal irritant in rabbits.⁵⁰ Occlusive patches containing 0.5 mL undiluted PPG-5-ceteth-20 were

applied for 24 hours to both intact and abraded skin of 3 rabbits; the test sites were clipped free of hair. The patches were described as 2×2 ; units were not provided. The test sites were evaluated for reactions upon patch removal and 48 hours later. No erythema, eschar formation, or edema was observed at any of the test sites 24 or 72 hours after application.

Nonhuman irritation and sensitization data on several analogous compounds available from previous safety assessments of the alkyl PEG ethers and PPGs indicate that these compounds range from nonirritating to moderately and severely irritating.² For example, under semioclusive conditions, C_{14-15} alkyl ethoxylate number (AE)₇, 0.5 mL at 10%, 25%, or 100%, was not irritating to rabbit skin. However, following a 4-hour occlusive application to rabbit skin, undiluted $\text{C}_{12-14}\text{AE}_{10}$ and undiluted C_{13}AE_6 were moderately irritating and undiluted $\text{C}_{13}\text{AE}_{6.5}$ and undiluted $\text{C}_{12-14}\text{AE}_6$ were severely irritating. Additionally, 50% propylene glycol may have caused skin irritation in nude mice, whereas 100% propylene glycol was nonirritating to minimally irritating in several species.^{3,5}

Human

PPG-5-ceteth-20 was not a primary irritant, fatiguing agent, or sensitizer in a human repeated insult patch test (HRIPT).⁵¹ Induction consisted of 10 occlusive patches containing 0.5 mL undiluted PPG-5-ceteth-20 applied to the inner aspect of the arm or forearm of 50 subjects. The first induction patch was applied for 48 hours and the remaining 9 patches for 24 hours; there was a 24-hour rest period between patches. The test site was evaluated for reactions upon removal of each patch. A 48-hour challenge patch was applied 10 to 14 days after the last induction patch. No reactions were observed in any of the subjects during induction or challenge.

Human irritation and sensitization data on analogous compounds are available from the safety assessments of the alkyl PEG ethers, and PPGs indicate that generally the ingredients were not strong irritants or sensitizers.

Summary

This report is a safety assessment of 131 alkyl PEG/PPG ethers that can be used in cosmetics. Alkyl PEG/PPG ethers are the reaction products of an alkyl alcohol and one or more equivalents each of ethylene oxide and propylene oxide (forming repeats of PEG and PPG, respectively). Each of the alkyl PEG/PPG ethers has surfactant properties, with a chain structure that has a hydrophobic end and a hydrophilic end; the dimethyl ethers are distinct in this group by being capped at both ends with methyl groups, instead of having 1 alkyl chain at 1 end. The alkyl PEG/PPG ethers are typically manufactured by (1) activating the alcohol by generating an alkoxide; (2) reacting the alkoxide with ethylene oxide, propylene oxide, or a mixture of both; and (3) terminating the propagation. The actual order of alkoxide repeats in each ingredient, and from each source of an ingredient, may be block, alternating, or random, and the propylene oxide placement affects the

physical and surface active properties. Based on this chemistry, the potentially carcinogenic compounds ethylene oxide and propylene oxide are present at residual levels, along with the residual byproduct 1,4-dioxane. In practice, these impurities are not present because of steps in the manufacturing process that remove them.

The alkyl PEG/PPG ethers are reported to function in cosmetics mostly as surfactants, skin-conditioning agents, and/or emulsifying agents. The VCRP data obtained from the FDA in 2013 and data received in response to a Council survey of maximum reported use concentration indicate that 26 of the alkyl PEG/PPG ethers named in this safety assessment are currently used in cosmetic formulations. PPG-5-ceteth-20 has the most reported uses (445) and the highest reported concentration in leave-on products (10%). Most of the in-use alkyl PEG/PPG ethers are used in less than 40 formulations and at concentrations of $\leq 5\%$.

In Europe, PPG-4-trideceth-6 can be used at 0.05 mg/kg in food contact materials; it is to be used only in PTFE items sintered at high temperatures. PPG-5-ceteth-20 is being evaluated for inclusion in dermal and nasal drug delivery systems.

Often, surfactants can be penetration enhancers. However, PPG-4-ceteth-20 did not enhance the penetration of tenoxicam through guinea pig skin.²

Undiluted PPG-5-ceteth-20 was predicted to be a mild-to-moderate dermal irritant based on the results of an MTT cytotoxicity assay, but it was not a primary irritant in rabbit skin nor was it a primary irritant, fatiguing agent, or sensitizer in a 50-subject HRIPT.

Discussion

Alkyl PEG/PPG ethers are the reaction products of an alkyl alcohol and one or more equivalents each of ethylene oxide and propylene oxide (forming repeats of PEG and PPG, respectively). The alkyl PEG/PPG ethers share very similar physiochemical properties with another family of ingredients that has been previously reviewed by the CIR Expert Panel and found safe when formulated to be nonirritating, that is, the alkyl PEG ethers. The only difference between the alkyl PEG ethers and the alkyl PEG/PPG ethers is the inclusion of PPG repeat units, which are used to simply fine-tune the surfactant properties of these ingredients. The PPGs have also been found safe when formulated to be nonirritating by the Panel.

Although there are little data available on the individual alkyl PEG/PPG ethers, the Panel stated that existing data on analogous ingredients (ie, from the alkyl PEG ethers and PPG safety assessments) support the safety of this ingredient family. These data provided the Panel with a good indication of a lack of toxicity of the alkyl PEG/PPG ethers. Additionally, the alkyl PEG/PPG ethers are larger molecules than alkyl PEG ethers and the PPGs, so they are less likely to penetrate the skin and enter the circulation. And, the maximum use concentration reported for the alkyl PEG/PPG ethers is lower than that reported in the safety assessments of the alkyl PEG ethers or the PPGs.

The Panel was concerned about the possibility of the presence of residual starting materials used in the manufacture of the alkyl PEG/PPG ethers (ie, ethylene oxide and propylene oxide) and of the residual by-product, 1,4-dioxane. These compounds are potentially carcinogenic. The Panel noted these are volatile compounds, and therefore, levels of these compounds in cosmetics are expected to be below the level of toxicological concern. Although levels may be low, the Panel stressed that the cosmetics industry should continue to use the necessary procedures to remove these impurities from the ingredients before blending them into cosmetic formulations.

The Panel recognized that some of the alkyl PEG/PPG ethers can enhance the penetration of other ingredients through the skin. The Panel cautioned that care should be taken in formulating cosmetic products that may contain these ingredients in combination with any ingredients whose safety was based on their lack of dermal absorption data or when dermal absorption was a concern.

Additionally, the Panel was also concerned that the potential exists for dermal irritation with the use of products formulated with alkyl PEG/PPG ethers. The Panel specified that products must be formulated to be nonirritating.

Finally, the Panel discussed the issue of incidental inhalation exposure of alkyl PEG/PPG ethers in products that could be inhaled. Because the alkyl PEG/PPG ethers are not expected to have chemical activity in biological systems, particles deposited in the nasopharyngeal or bronchial regions of the respiratory tract present no toxicological concerns. Coupled with the small actual exposure in the breathing zone, the expected particle size, and the concentrations at which the ingredients are used, the available information indicates that incidental inhalation would not be a significant route of exposure that might lead to local respiratory or systemic effects. A detailed discussion and summary of the Panel's approach to evaluating incidental inhalation exposures to ingredients in cosmetic products that may be aerosolized is available at <http://www.cir-safety.org/cir-findings>.

Conclusion

The CIR Expert Panel concluded that the following 131 alkyl PEG/PPG ethers are safe in the present practices of use and concentration in cosmetics described in this safety assessment when formulated to be nonirritating.

PEG-4-PPG-7 C13/C15 alcohol*
PEG/PPG-3/6 dimethyl ether*
PEG/PPG-7/12 dimethyl ether*
PEG/PPG-9/2 dimethyl ether
PEG/PPG-14/7 dimethyl ether
PEG/PPG-17/4 dimethyl ether
PEG/PPG-22/40 dimethyl ether*
PEG/PPG-27/14 dimethyl ether*
PEG/PPG-35/40 dimethyl ether
PEG/PPG-36/41 dimethyl ether
PEG/PPG-50/40 dimethyl ether
PEG/PPG-52/32 dimethyl ether*

PEG/PPG-55/28 dimethyl ether
PEG/PPG-4/2 propylheptyl ether*
PEG/PPG-6/2 propylheptyl ether*
PEG-7/PPG-2 propylheptyl ether*
PEG/PPG-8/2 propylheptyl ether*
PEG/PPG-10/2 propylheptyl ether*
PEG/PPG-14/2 propylheptyl ether*
PEG/PPG-40/2 propylheptyl ether*
PPG-2-cetareth-9
PPG-4-cetareth-12*
PPG-10-cetareth-20*
PPG-1-ceteth-1*
PPG-1-ceteth-5*
PPG-1-ceteth-10*
PPG-1-ceteth-20*
PPG-2-ceteth-1*
PPG-2-ceteth-5*
PPG-2-ceteth-10
PPG-2-ceteth-20*
PPG-4-ceteth-1*
PPG-4-ceteth-5*
PPG-4-ceteth-10*
PPG-4-ceteth-20
PPG-5-ceteth-20
PPG-8-ceteth-1
PPG-8-ceteth-2*
PPG-8-ceteth-5*
PPG-8-ceteth-10
PPG-8-ceteth-20
PPG-2 C9-11 pareth-5*
PPG-2 C9-11 pareth-7*
PPG-2 C9-11 pareth-8*
PPG-2 C9-11 pareth-11*
PPG-2 C12-13 pareth-8
PPG-2 C12-15 pareth-6*
PPG-4 C13-15 pareth-15*
PPG-5 C9-15 pareth-6*
PPG-6 C9-11 pareth-5*
PPG-6 C12-15 pareth-12*
PPG-6 C12-18 pareth-11*
PPG-3 C12-14 Sec-pareth-7*
PPG-4 C12-14 Sec-pareth-5*
PPG-5 C12-14 Sec-pareth-7*
PPG-5 C12-14 Sec-pareth-9*
PPG-1-deceth-4*
PPG-1-deceth-5*
PPG-1-deceth-6*
PPG-1-deceth-7*
PPG-2-deceth-3
PPG-2-deceth-5*
PPG-2-deceth-7*
PPG-2-deceth-8*
PPG-2-deceth-10*
PPG-2-deceth-12
PPG-2-deceth-15*
PPG-2-deceth-20*
PPG-2-deceth-30*
PPG-2-deceth-40*
PPG-2-deceth-50*
PPG-2-deceth-60*
PPG-4-deceth-4*
PPG-4-deceth-6*
PPG-6-deceth-4*
PPG-6-deceth-9*
PPG-8-deceth-6*
PPG-14-deceth-6*
PPG-6-decyltetradeceth-12*
PPG-6-decyltetradeceth-20
PPG-6-decyltetradeceth-30
PPG-13-decyltetradeceth-24
PPG-20-decyltetradeceth-10
PPG-9-ethylhexeth-5*
PPG-1-isodeceth-4*
PPG-1-isodeceth-6*
PPG-1-isodeceth-7*
PPG-1-isodeceth-9*
PPG-2-isodeceth-4*
PPG-2-isodeceth-6*
PPG-2-isodeceth-8*
PPG-2-isodeceth-9*
PPG-2-isodeceth-10*
PPG-2-isodeceth-12
PPG-2-isodeceth-18*
PPG-2-isodeceth-25*
PPG-3-isodeceth-1*
PPG-4-isodeceth-10*
PPG-3-isosteareth-9
PPG-2-laureth-5*
PPG-2-laureth-8*
PPG-2-laureth-12*
PPG-3-laureth-8*
PPG-3-laureth-9*
PPG-3-laureth-10*
PPG-3-laureth-12*
PPG-4-laureth-2*
PPG-4-laureth-5*
PPG-4-laureth-7*
PPG-4-laureth-15*
PPG-5-laureth-5
PPG-6-laureth-3*
PPG-25-laureth-25
PPG-3-myreth-3*
PPG-3-myreth-11*
PPG-2-PEG-11 hydrogenated lauryl alcohol ether*
PPG-3-PEG-6 oleyl ether*
PPG-9-steareth-3*
PPG-23-steareth-34*
PPG-30 steareth-4*
PPG-34-steareth-3
PPG-38 steareth-6*
PPG-1-trideceth-6
PPG-1-trideceth-13*

PPG-4-trideceth-6*
 PPG-6-trideceth-8*
 Propylene glycol capreth-4*
 Propylene glycol isodeceth-4*
 Propylene glycol isodeceth-12*
 Propylene glycol laureth-6*
 Propylene glycol oleth-5*

*Not reported to be in current use. Were ingredients in this group not in current use to be used in the future, the expectation is that they would be used in product categories and at concentrations comparable to others in this group.

Authors' Note

Unpublished sources cited in this report are available from the Director, Cosmetic Ingredient Review, Washington, DC.

Author Contributions

M. Fiume contributed to conception and design, contributed to acquisition, analysis, and interpretation, and drafted the manuscript. B. Heldreth contributed to conception and design, contributed to acquisition, analysis, and interpretation, drafted the manuscript, and critically revised the manuscript. L. Gill, F. Alan Anderson, W. Bergfeld, D. Belsito, R. Hill, C. Klaassen, D. Liebler, J. Marks, R. Shank, T. Slaga, and P. Snyder contributed to conception and design, contributed to analysis and interpretation, and critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

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References

- Gottschalk TE, Breslawec H. *International Cosmetic Ingredient Dictionary and Handbook*. Washington, DC: Personal Care Products Council; 2012.
- Fiume MM, Heldreth BA, Bergfeld WF, et al. Safety assessment of alkyl PEG ethers as used in cosmetics. *Int J Toxicol*. 2012; 31(suppl 2):169-244.
- Fiume MM, Bergfeld WF, Belsito DV, et al. Safety assessment of propylene glycol, tripropylene glycol, and PPGs as used in cosmetics. *Int J Toxicol*. 2012;31(suppl 2):245-260.
- Lindner GJ. Chemical clustering for risk assessment: fatty alcohol alkoxyates. *J ASTM Intl*. 2010;7(7):15-31.
- AkzoNobel. Berol 185. Web site. <http://sc.akzonobel.com/en/fa/Pages/product-detail.aspx?prodID=8219>. Accessed February 05, 2013. Updated 2013.
- Angene. Oxirane, methyl-, polymers, polymer with oxirane, monohexadecyl ether. Web site. <http://www.angenechem.com/product/AG-F-30935/>. Accessed January 22, 2013. Updated 2010.
- Chemical-Navi. Nikkol PBC-31—product details. Web site. http://www.chemical-navi.com/english/product_search/detail162.html. Accessed February 05, 2013. Updated 2010.
- Chemical-Navi. Nikkol PBC-33. Web site. https://www.chemical-navi.com/english/product_search/detail163.html. Accessed February 5, 2013. Updated 2010.
- Chemical-Navi. Nikkol PBC-34. Web site. https://www.chemical-navi.com/english/product_search/detail164.html. Accessed February 05, 2013. Updated 2010.
- Dow Chemical Company. Material Safety Data Sheet; ECOSURF™ EH-3 Surfactant. Web site. <http://www.dow.com/webapps/msds/ShowPDF.aspx?id=090003e880248bfb>. Accessed February 04, 2013. Updated February 24, 2012.
- Global Seven, Inc. Hetoxol CAWS. Web site. <http://www.globalseven.com/backup2/caws.html>. Accessed February 05, 2013. Updated 2002.
- INEOS Oxide. Softanol—technical data. Web site. <http://www.ineos.com/Show-Documents/?Grade=Softanol%2070&BU=INEOS%20Oxide&DocumentType=Technical%20Data%20Sheet>. Accessed February 05, 2013. Updated 2004.
- Nihon Emulsion Co Ltd. Polyoxyethylene-polypropylene decyl ethers—EMALEX products. Web site. <http://www.nihon-emulsion.co.jp/english/products/list/E-DAPEfm.htm>. Accessed February 05, 2013. Updated 2001.
- Sasol. Surfactants—product range. Web site. <http://www.sasoltechdata.com/MarketingBrochures/Surfactants.pdf>. Accessed February 05, 2013. Updated 2010.
- SpecialChem. Nikkol PEN-4612. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pen-4612/nikkol/4498/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PEN-4620. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pen-4620/nikkol/4499/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PEN-4630. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pen-4630/nikkol/4500/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Hetoxol I-10-P3-E. Web site. <http://www.specialchem4cosmetics.com/tds/hetoxol-i-10-p3-ei/global-seven/6221/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PBC-33. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pbc-33/nikkol/4491/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PBC-34. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pbc-34/nikkol/4492/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Procetyl™ AWS. Web site. <http://www.specialchem4cosmetics.com/tds/procetyl-aws/croda/2835/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PBC-41. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pbc-41/nikkol/4493/index.aspx>. Accessed February 05, 2013. Updated 2013.
- SpecialChem. Nikkol PBC-44. Web site. <http://www.specialchem4cosmetics.com/tds/nikkol-pbc-44/nikkol/4494/index.aspx?q=nikkolpbc-44>. Accessed February 05, 2013. Updated 2013.

24. Vevy Europe. ADF-Oleile. Web site. <http://www.vevy.com/Products/ADF-OLEILE/>. Accessed February 05, 2013. Updated 2008.
25. Zschimmer & Schwarz GmbH & Co KG. Propetal 130. Web site. http://www.zschimmer-schwarz.com/PROPETAL_130/simon/zschimmer-schwarz/media/site/downloads/merkblatt/1_S_S_ENG_4497_20_2_900.pdf. Accessed February 05, 2013. Updated 2013.
26. Zschimmer & Schwarz GmbH & Co KG. Mulsifan CTP 14. Web site. http://www.zschimmer-schwarz.com/MULSIFAN_CTP_14/simon/zschimmer-schwarz/media/site/downloads/merkblatt/1_S_S_ENG_3782_20_2_370.pdf. Accessed February 05, 2013. Updated 2013.
27. Dück R, Wulf V, Geissler M, Baier H-U, et al. Combination of chemical and electron-impact ionisation with GC+uGC-qMS for characterization of fatty alcohol alkoxyate polymers in the low-molecular-weight range up to 700 Da. *Anal Bioanal Chem*. 2010; 396(6):2273-2283.
28. Hinton C. Alkoxylated Nonionic Surfactants. Chapter: 3. In: Schlossman ML, ed. *The Chemistry and Manufacture of Cosmetics*. Volume III—Ingredients. Carol Stream, IL: Allured Publishing Company; 2002:15-27.
29. Naylor CG. Nonionic surfactants containing propylene oxide. *J Am Oil Chem Soc*. 1986;63(9):1201-1208.
30. In Cosmetics. ADF-oleile. Web site. http://www.in-cosmetics.com/_novadocuments/2934. Accessed February 05, 2013. Updated 2013.
31. National Toxicology Program. Ethylene oxide. Report on Carcinogens, Twelfth Edition. Web site. <http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/EthyleneOxide.pdf#search=ethylene%20oxide>. Accessed January 22, 2013. Updated 2011.
32. National Toxicology Program. Propylene oxide. Report on Carcinogens, Twelfth Edition. Web site. <http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/PropyleneOxide.pdf#search=propylene%20oxide>. Accessed January 22, 2013. Updated 2011.
33. National Toxicology Program. 1,4-Dioxane. Report on Carcinogens, Twelfth Edition. Web site. <http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Dioxane.pdf#search=1,4-dioxane>. Accessed June 12, 2013. Updated 2011.
34. World Health Organization, International Agency for Research on Cancer. Volume 60. Some industrial chemicals. Summary of data reported and evaluation. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Web site. <http://monograph.s.iarc.fr/ENG/Monographs/vol60/volume60.pdf>. Accessed January 22, 2013. Updated April 13, 1999.
35. World Health Organization, International Agency for Research on Cancer. Volume 71. Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide. Web site. <http://monograph.s.iarc.fr/ENG/Monographs/vol71/volume71.pdf>. Accessed June 12, 2013. Updated 1999.
36. Food and Drug Administration. *Frequency of Use of Cosmetic Ingredients*. FDA Database. Washington, DC: Food and Drug Administration; 2013.
37. Personal Care Products Council. 3-21-2013. Concentration of use by FDA product category: alkyl PEG/PPG ethers. 11 pages.
38. Personal Care Products Council. 5-2-0013. Concentration of use by FDA product category: PEG/PPG-14/2 propylheptyl ether. 1 pages.
39. Johnsen MA. The influence of particle size. *Spray Technol Mark*. 2004;14(11):24-27.
40. Rothe H. Special Aspects of Cosmetic Spray Evaluation. Unpublished data presented at the CIR Expert Panel Meeting; Washington, DC; September 26, 2011.
41. Rothe H, Fautz R, Gerber E, et al. Special aspects of cosmetic spray safety evaluations: principles on inhalation risk assessment. *Toxicol Lett*. 2011;205(2):97-104.
42. Bremmer HJ, Prud'homme de Lodder LCH, Engelen JGM. Cosmetics Fact Sheet: To assess the risks for the consumer; Updated version for ConsExpo 4. Report No. RIVM 320104001/2006. 2006:1-77.
43. European Commission. CosIng database; following Cosmetic Regulation No. 1223/2009. Web site. <http://ec.europa.eu/consumers/cosmetics/cosing/>. Accessed September, 23, 2013. Updated 2013.
44. AFC Panel. Scientific Panel on food additives, flavourings, processing aids and materials in contact with food). 13th List of Food Contact Materials. Web site. <http://www.efsa.europa.eu/en/scdocs/doc/418.pdf>. *The EFSA Journal*. Accessed January 22, 2013. Updated 2006.
45. Encyclopedia Britannica. Polytetrafluoroethylene (PTFE). Web site. <http://www.britannica.com/EBchecked/topic/469146/polytetrafluoroethylene-PTFE>. Accessed February 11, 2013. Updated 2013.
46. Carvalho FC, Rocha e Silva H, et al. Rheological, mechanical and adhesive properties of surfactant-containing systems designed as a potential platform for topical drug delivery. *J Biomed Nanotechnol*. 2012;8(2):280-289.
47. Carvalho FC, Barbi MS, Sarmento VHV, Chiavacci LA, Netto FM, Gremião MPD. Surfactant systems for nasal zidovudine delivery: structural, rheological and mucoadhesive properties. *J Pharm Pharmacol*. 2010;62(4):430-439.
48. Endo M, Yamamoto T, Ijuin T. Effect of nonionic surfactants on the percutaneous absorption of tenoxicam. *Chem Pharm Bull*. 1996;44(4):865-867.
49. Stephens Thomas J.&Associates Inc. . Mattek Corporation Epiderm® skin model (EPI-100). Irritation potential of undiluted PPG-5-Ceteth-20. 1994.
50. Leberco Laboratories. PPG-5-Ceteth-20: Acute dermal irritation study in rabbits. 1973.
51. Bio-Toxicology Laboratories. Repeated insult patch test of PPG-5-Ceteth-20. 1973.
52. European Commission. European Commission Health and Consumers Cosmetics—CosIng—Database. Web site. <http://ec.europa.eu/consumers/cosmetics/cosing/>. Accessed January 13, 2012. Updated 2010.
53. Personal Care Products Council. 1-31-2013. Propylene glycol isodeceth-4 and PPG-1-isodeceth-4.