

Cod: 4.5025

## EMERGING 'COMPOUNDS OF CONCERN' WITH POP-LIKE PROPERTIES: AN OVERVIEW

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### Introduction

During the past century, a vast number of organic chemicals have been manufactured and used in industrial, agricultural, public health, consumer products and other applications. Widespread use of organohalogens, including chlorinated, brominated and fluorinated compounds, lead to environmental contamination and human exposures<sup>1,2</sup>. Among the organohalogens, chlorinated compounds such as PCBs and pesticides very rapidly contaminated the environment and biota during the periods of their use for agricultural and public health purposes. The contamination levels declined after the ban/severe restrictions placed on the production and use of these compounds in most of the developed countries. In the recent years, new organohalogens (especially brominated and perfluorinated compounds) and other compounds used in industries, pharmaceutical and personal care products are continue to be discovered in the environment and biological samples. Several of these compounds exhibit physical and chemical properties similar to classical persistent organic pollutants (POPs). This overview deals with 'Compound of Concern' with POP-like properties for future environmental and health issues.

### POP-Like Properties

Classical persistent organic pollutants (polychlorinated biphenyls (PCBs), organochlorine pesticides and dioxins etc) have physicochemical and biochemical properties such as water solubility, vapor pressure, lipophilicity, biodegradability and particle affinity were at appropriate magnitude to make them stable in the environmental media, bioaccumulate and biomagnify in food chain and cause chronic toxic effects<sup>2</sup>. Several of the new emerging pollutants discovered in the recent years also exhibit POP-like properties. The compounds that exhibit POPs-like properties are presented in presented in Table 1.

### Compounds of Concern

The emerging persistent organic compounds of concern with POP-like properties are grouped as (i) Flame retardants, (ii) Perfluorinated compounds (PFCs) and other industrial chemicals (iii) Pharmaceuticals (iv) Personal care products. These compounds were detected in one or more environmental media (air, water, soil, sediment) and/or biota (aquatic, terrestrial organisms)<sup>3-10</sup>. The compounds of concern that were detected in any one or more of environmental and biological sample(s) are listed in the Table 1.

Recent studies have revealed occurrence of several compounds used in flame retardants and alternative compounds introduced to serve as flame retardants, industrial chemicals including perfluorinated compounds, bisphenol A and its derivatives, pharmaceuticals and personal care products in various environmental media from both developed and developing countries. Based on these reports, it may be surmised that compounds of concern with POP-like properties will be of concern for future environmental and health problems (Figure 1).

Classical organochlorines, due to their recalcitrant properties, exposure pathway is complicated involving environmental contamination, bioaccumulation and biomagnification in the food chain and ultimately reaches top predators such as humans in the terrestrial ecosystem and marine mammals in the aquatic ecosystem. This process takes relatively longer time to reach humans from the time of application or use. Whereas, emerging new compounds of concern are used or applied directly to the human skin or consumed via contaminated water and/or food. Particularly, human exposure pathway for pharmaceuticals and personal care products are direct and intimate. Based on the use and their POP-like property, it can be predicted that the environmental contamination as well as human exposure and

health effects by these compounds will continue to increase for several decades in both developed as well as developing countries.

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Table 1. 'Compounds of Concern' for future environmental and health issues. Prepared based on references 3-10.

Compound Name (CAS Number)	Abbreviation
<b>(i) Flame Retardants</b>	
1,2-Bis(2,4,6-tribromophenoxy)ethane (37853-59-1)	BTBPE
1,2-Bis(tetrabromophthalimido)ethane (32588-76-4)	BTBPIE
5,6-Dibromo-1,10,11,12,13,13-hexachloro-11-tricyclo[8.2.1.02,9]tridecene (51936-55-1)	DBHC-TCTD or HCDBCO
Decabromodiphenylethane (84852-53-9)	DBDPE
Di(ethylhexyl)tetrabromophthalate (26040-51-7)	DEHTBP or TBPH
Dechlorane Plus, Bis(hexachlorocyclopentadieno)cyclo-octane (13560-89-9)	DP
2-Ethylhexyl-2,3,4,5-tetrabromobenzoate (183658-27-7)	EH-TBB or TBB
Hexabromobenzene (87-82-1)	HBB
Hexabromocyclododecane, major isomers are $\alpha$ , $\beta$ , $\gamma$ -HBCDD (3194-55-6)	HBCD or HBCDD
Pentabromoethylbenzene (85-22-3)	PBEB
Pentabromotoluene (87-83-2)	PBT
Tetrabromobisphenol A (79-94-7)	TBBPA
Tetrabromobisphenol A diallyl ether (25327-89-3)	TBBPA-DAE
Tetrabromobisphenol A bis(2,3-dibromopropyl) ether (21850-44-2)	TBBPA-DBPE
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane (3322-93-8)	TBECH
2,4,6-tribromophenyl allyl ether (3278-89-5)	TBP-AE or ATT
Tris(2-chloroethyl)phosphate (115-96-8)	TCEP
Tris(1,3-dichloroisopropyl)phosphate (13674-87-8)	TDCPP or TDCP
Short-chain chlorinated paraffins (85535-84-8 and 71011-12-6)	SCCP
<b>(ii) PFCs and other Industrial Chemicals</b>	
Perfluorooctane sulfonyl fluoride (1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptafluorooctane-1-sulfonyl fluoride) (307-35-7)	POSF
Perfluorooctane sulfonic acid (1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptafluorooctane-1-sulfonic acid) (1763-23-1)	PFOS
Perfluorooctane sulfonate Potassium salt (1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptafluorooctane-1-sulfonate Potassium salt) (2795-39-3)	PFOS K
<i>N</i> -ethyl-perfluorooctanesulfonamide (1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptafluorooctane-1-sulfonamide) (754-91-6)	<i>N</i> -EtFOSA
Perfluorobutanoic acid (2,2,3,3,4,4,4-heptafluorobutanoic acid) (375-22-4)	PFBA
Perfluoropentanoic acid (2,2,3,3,4,4,5,5,5-nonafluoropentanoic acid) (2706-90-3)	PFPeA
Perfluorohexanoic acid (2,2,3,3,4,4,5,5,6,6,6-undecafluorohexanoic acid) (307-24-4)	PFHxA
Perfluoroheptanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,7-tridecafluoroheptanoic acid) (375-85-9)	PFHpA
Perfluorooctanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-pentadecafluorooctanoic acid) (335-67-1)	PFOA
Perfluorononanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptafluorononanoic acid) (375-95-1)	PFNA
Perfluorodecanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluorodecanoic acid) (335-76-2)	PFDA
Perfluoroundecanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-henicosafuoroundecanoic acid) (2058-94-8)	PFUnDA
Perfluorododecanoic acid (2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-tricosafuorododecanoic acid) (307-55-1)	PFDoDA
8:2 fluorotelomer alcohol (3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptafluoro-1-decanol) (678-39-7)	8:2 FTOH
<b>Components of Fire-Fighting Foams</b>	
Perfluorooctane sulfonate	PFOS
Perfluorohexanesulphonate	PFHxS
Perfluorobutanesulphonate	PFBS
Perfluorooctanesulfonamide (PFOSA)Pperfluoro-decanoate	PFDA

Perfluorononanoate	PFNA
Perfluorooctanoate	PFOA
Perfluoro-heptanoate	PFHpA
Perfluoroundecanoate	PFUnDA
Perfluoro-hexanoate	PFHxA
Other Industrial Chemicals	
Bisphenol A, (4,4-dihydroxy-2,2-diphenyl propane) (80-05-7)	BPA
Bisphenol AF (hexafluorobisphenol A), (1,1,1,3,3,3-hexafluoro-2,2-bis(4-hydroxyphenyl)propane) (1478-61-1)	BPAF
Bis(2-ethylhexyl)tetrabromophthalate (26040-51-7)	BEHTBP
(iii) Pharmaceuticals	
Macrolide antibiotics	
Carbamazepine	
(iv) Personal Care Products	
Musk Fragrances	
1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylcyclopenta[g]-2- benzopyrane (1222-05-5) HHCB	
7-acetyl-1,1,3,4,4,6-hexamethyltetrahydronaphthalene (1506-02-1)	AHTN
UV Stabilizers	
2-(3-t-butyl-2-hydroxy-5-methylphenyl)-5-chlorobenzotriazole (3896-11-5)	UV-326
2,4-di-t-butyl-6-(5-chloro2H-benzotriazol-2-yl) phenol (3864-99-1)	UV-327
2-(2H-benzotriazol-2-yl)-4,6-di-t-pentylphenol (25973-55-1)	UV-328

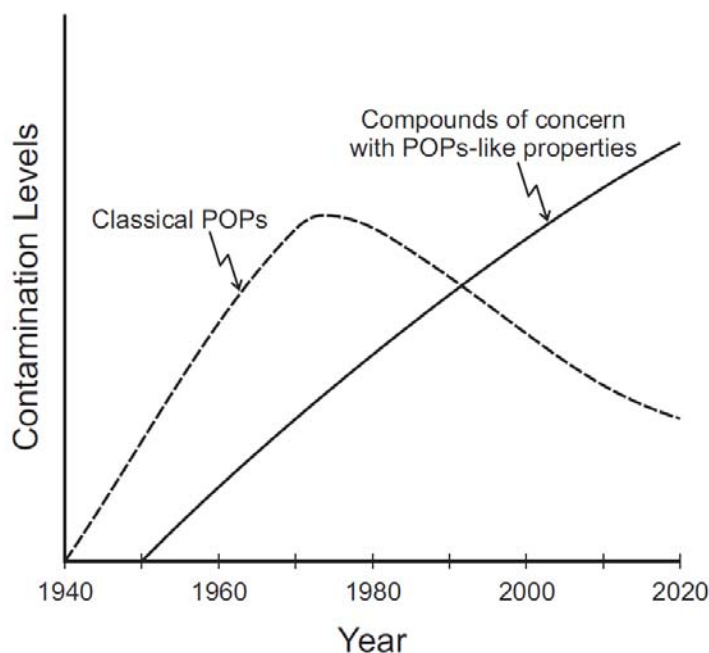


Figure 1. A schematic representation of time perspectives of classical POPs and compounds of concern with POP-like properties.