

Delivering an integrated data hub for per- and polyfluoroalkyl (PFAS) chemicals via the US EPA CompTox Chemicals Dashboard

Antony Williams¹, Chris Grulke¹, Kamel Mansouri², Grace Patlewicz¹ and Ann Richard¹ ¹U.S. Environmental Protection Agency, Office of Research and Development, National Center for Computational Toxicology, Research Triangle Park, NC and ²Integrated Laboratory Systems, Research Triangle Park, NC.

Problem Definition and Goals

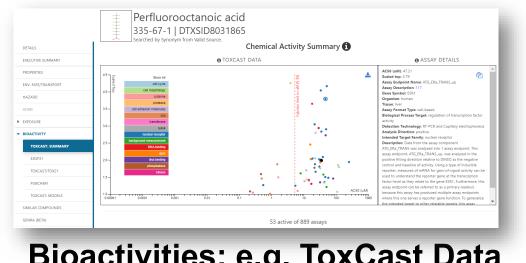
Problem: There are many sources of PFAS data online to support computational toxicology. However, curated datasets for the thousands of known PFAS chemicals are not available in structured formats,

Goals: Deliver online access to hundreds of thousands of chemicals of interest to environmental science and computational toxicology. Provide lists of PFAS substances via a simple to use web-based interface. Deliver application to support diverse types of data including experimental and predicted physicochemical properties, in vivo hazard data and in vitro toxicity and toxicokinetic data. Make the data available as downloadable data for reuse and repurposing in other databases.

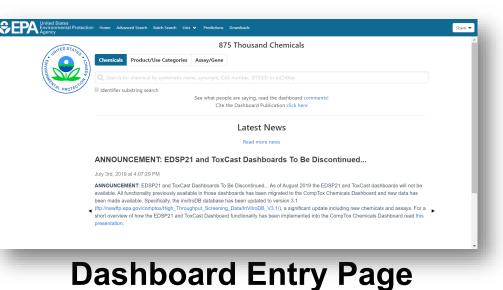
Abstract

There is increasing interest in the environmental impact of per- and polyfluoroalkyl substances (PFAS) chemicals and the aggregation of related data provides both agency and public access to support US-EPA's CompTox Chemicals Dashboard research. The (https://comptox.epa.gov/dashboard) is a publicly accessible website providing access to data for ~875,000 chemical substances, including thousands of PFAS chemicals. The dashboard provides access to a wide array of experimental and predicted physicochemical properties, in vitro bioactivity and in vivo toxicity data, product use information and integrated linkages to a growing list of literature, toxicology, and analytical chemistry websites. The assembly of data has required hundreds of hours of manual curation and data checking to deliver a number of segregated lists of PFAS chemicals. Experimental data extracted from literature articles has allowed the optimization of QSAR models for the prediction of properties such as logP (octanolwater partition) and aqueous solubility. This poster provides an overview of the dashboard, the ongoing expansion of the PFAS chemical library, with associated categorization, and new physicochemical property and environmental fate and transport QSAR prediction models being developed for these chemicals. Our work in the measurement and analysis of bioactivity data for PFAS chemicals will also be reviewed.

This abstract does not necessarily represent the views or policies of the U.S. Environmental Protection Agency.



The CompTox Chemicals Dashboard



Where possible, links are related Wikipedia provided to articles. Structure file formats are available for download to the desktop (SMILES and molfile) executive summary an and report regarding chemical toxicity is provided.

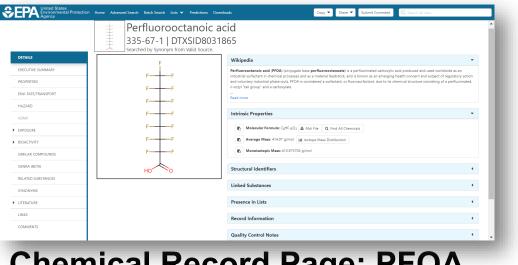
RY	Summary							
		Summary						
DRT	🛓 Download 🔻 Columns 🗸							
	Property \$	Experimental average +	Predicted average \$	Experimental median +	Predicted median \$	Experimental range 🕈	Predicted range +	Unit
	LogP: Octanol-Water	3.60 (1)	5.51		5.57	3.60	2.95 to 7.75	
	Melting Point	57.0 (14)	34.6	56.5	40.6	54.3 to 59.5	-8.69 to 65.7	°C
	Boiling Point	189 (9)	192	189	190	188 to 191	188 to 204	°C
	Water Solubility	1.56e-2 (4)	1.01e-2	1.55e-2	6.38e-5	8.21e-3 to 2.29e-2	6.27e-8 to 4.01e-2	mol/L
IDS	Vapor Pressure	2.23 (5)	0.245	0.525	0.307	1.70e-2 to 10.0	2.24e-2 to 0.345	mmHg
	Flash Point		68.0		68.0		62.1 to 73.9	°C
	Surface Tension		16.8				16.8	dyn/cm
:ES	Index of Refraction		1.29				1.29	
	Molar Refractivity		42.9				42.9	cm^3
	Polarizability		17.0				17.0	A^3
	Density	1.80 (1)	1.72		1.72	1.80	1.70 to 1.75	g/cm^3
	Molar Volume		237				237	cm^3
	Thermal Conductivity		65.3				65.3	mW/(m*K)
	Henry's Law		2.02e-10				2.02e-10	atm-m3/mole
	LogKoa: Octanol-Air		4.16				4.16	
	pKa Acidic Apparent	3.15 (2)		3.15		2.50 to 3.80		

Chemical Properties Panel

The Hazard tab provides access to data assembled from a series of public resources including EPA data (i.e. IRIS and PPRTV reports, ToxRef DB). Data can be downloaded as TSV and Excel files.

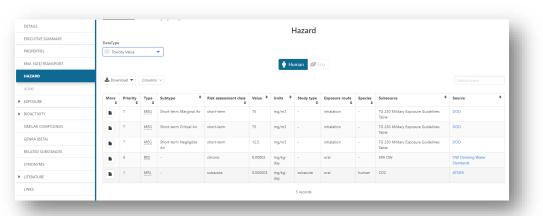
Bioactivities: e.g. ToxCast Data

The the landing page Of dashboard is a simple text entry allowing type-ahead а box search for systematic, trade and CAS trivial Registry names, InChl chemical Numbers and identifiers.



Chemical Record Page: PFOA

chemical with For records structures experimental and predicted physicochemical (logP, water solubility etc.) and fate and transport properties are provided. These include OPERA models reported by Mansouri et al. [1]



Toxicity Values Panel

ToxCast Bioactivity data measured over the past decade are under the Bioassay Tab. Data can be downloaded as Excel files. New in vitro data are being generated on a library of ~150 PFAS in collaboration with NTP.

Accessing PFAS Chemical Lists

The dashboard provides access to ~20 individual PFAS chemical lists. These include a list based on structural filters: (1) Formula must contain 3 -1000 Fluorine atoms; 2) Structure must contain two adjacent CF2 groups, either in a chain or in a ring system; 3) Fluorine to Carbon ratio (#F/#C) = or > 0.5; 4) **REMOVE** charged species (e.g., bare anions), radicals, and deuterium- and C13-labeled chemicals

🛓 Download 🔻	Columns v	
List Acronym 🗘	List Name	
EPAPFAS75S1	PFAS EPA: Lie (Set 1)	
EPAPFAS75S2	PFAS EPA: Lit (Set 2)	
EPAPFASCAT	PFAS[EPA Str Categories	
EPAPFASDW	PFASJEPA: N Drinking Wa	
EPAPFASDW537	PFASJEPAJW Method 537	
EPAPFASDWTREAT	PFASJEPAJW Treatment T	
EPAPFASINSOL	PFASJEPA: Cl Insoluble in	
EPAPFASINV	PFASJEPA: To Inventory	
EPAPFASINVIVO	PFASJEPA: In	
EPAPFASLITSEARCH	PFAS EPA: Li Completed:	

LIST chemi

A list of Markush Representations associated with the selection of chemicals for in vitro toxicity and toxicokinetic screening is also available [2,3].

Future Work

- dashboard.

References

Acknowledgements

Innovative Research for a Sustainable Future

ACS Fall 2019 San Diego, CA August 25-29, 2019



ORCID: 0000-0002-2668-4821 Antony Williams I williams.antony@epa.gov I 919-541-1033

	-						
Home Advanced Search		Lists 💙 Predictions Do	ownloads Share 🔻 📿 Search all data		PFAS EPA: PFAS sti	ructures in DSSTox	
✓ 10 ♥			PFAS Copy Filtered Lists URL	• Q. s			
me \$	Last Updated	• Number of Chemicals •	List Description \$	lden	ntifier substring search		
PA: List of 75 Test Samples	2018-06-29	74	PFAS list corresponds to 75 samples (Set 1) submitted for initial testing screens conducted by EPA researchers in collaboration with researchers at the National Toxicology Program.	List Details			
PA: List of 75 Test Samples	2019-02-21	75	PFAS list corresponds to a second set of 75 samples (Set 2) submitted for testing screens conducted by EPA researchers in collaboration with researchers at the National Toxicology Program.	below are designed to be simple, reproducible and other published DSSTox PFAS lists (e.g., PFASOECD	th a structure assigned, and where the structure satisfies a set of filter d transparent, yet general enough to encompass the largest set of stru v) will not satisfy these criteria (e.g., chemicals with large organic mole compared to the structure of the str	ructures having sufficient levels of fluorination to potentially imp eties and small fluoroethyl side chains), and over 1000 structures	art PFAS-type properties. Some structures containe s from the larger DSSTox inventory are included that
PA Structure-based ries	2018-06-29	64	List of registered DSSTox "category substances" representing PFAS categories created using ChemAxon's Markush structure-based query representations.		5" list. 1) Formula must contain 3 -1000 Fluorine atoms 2) Structure mi .g., anions), radicals, and deuterium- and C13-labeled chemicals	ust contain two adjacent CF2 groups, either in a chain or in a rir	ig system 3) Fluorine to Carbon ratio (#F/#C) = or >
PA: New EPA Method ig Water	2019-04-17	26	EPA is developing and validating a new method for detecting these PFAS in drinking water sources.				
PA WATER: Existing EPA DW d 537.1	2019-05-19	19	EPA has recently revised method \$37.1 for the PFAS on this list to detect them in drinking water.	Select all 🛃 Download 🔻 Send to Batch S		97 chemicals X Y Hide che	emicals that are: 👻 buty
PAĮWATER: Drinking Water ent Technology	2019-05-19	9	EPA is gathering and evaluating treatment effectiveness and cost data for removing these PFAS from drinking water systems.		• • • • • • • • • • • • • • • • • • •	•	
PA: Chemical Inventory ele in DMSO	2018-06-29	43	PFAS chemicals included in EPA's expanded ToxCast chemical inventory found to be insoluble in DMSO above 5mM.	XI. X	I		÷
PA: ToxCast Chemical ory	2018-06-29	430	PFAS chemicals included in EPA's expanded ToxCast chemical inventory and available for testing.		FFF	HE	
A: In Vivo Studies Available	2019-04-17	23	These PFAS have published animal toxicity studies available in the online HERO database.		F	111	5 m,
PA: Literature Search eted:	2019-04-17	23	A literature review of published toxicity studies for these PFAS	Perfluorotributvismine	F Heptafluorobutyl iodide	1H.1H-Perfluorobutyl acrylate	1-Butanesulfonamide, 1,1,2,2,3,3,4,4,-n,
		<< < 1 2 Showing 1 to 1	2 3 > >> 0 of 21 records	DTXSID: DTXSID0027141 CASRN: 311-89-7 TOXCAST: -	DTXSID: DTXSID4059912 CASRN: 374-98-1 TOXCAST: -	DTXSID: DTXSID8059978 CASRN: 424-64-6 TOXCAST: -	DTXSID: DTXSID2061147 CASRN: 812-94-2 TOXCAST: -
of c	he	mica	al lists of PFAS	Struc	ture-filter	ed list of	PFAS
nical	s: 2	21 lis	sts and growing				
			0	Select all 👗 Download 🔻 Send to Batch Se		54 chemicals ss: X V Hide chem	micals that are: Filter by Name or CASRN
						0	
N/12	rki	ISh	Representations			Ĭ	

Structure-filtered list of PFAS						
elect all 🔹 Download 🔻 Send to Batch Search 🛛 🕬	64 c	hemicals	als that are: V Filter by Name or CASRN			
Fluorotelomer (Inex) sufforc kids CASHN NOCA (SPS58 DDDSD: DDRIADO020258 Monx.Max: 0	Functedomer (Inear) acoholi CASIN: MOCA 59551 DISAID: DISAID: DISAID: DISAID: Mono.Masc 0	Thurostelomer (Incel) n2 acystes CASIN NOCA (\$5558 DOSID) DIVISIONSS2 Mono.Masc 0	$ \begin{array}{c} + \underset{l}{\overset{H}{\overset{H}}} \underset{H}{\overset{H}{\overset{H}}} \underset{h}{\overset{H}}} \underset{h}{\overset{H}{\overset{H}}} \underset{h}{\overset{H}} \underset{h}{\overset{H}}} \underset{h}{\overset{H}} \underset{H}} \underset{h}{\overset{H}} \underset{H}} \underset{h}{\overset{H}} \underset{H}{\overset{H}} \underset{H}} \underset{H}{\overset{H}} \underset{H} \underset{H}} \underset{H}{\overset{H}} \underset{H}} \underset{H} \underset{H}} \underset{H}} \underset{H}} \underset{H} H$			
H H H H H H H H H H H H H H	Fluoretelomer (Inser) unites (secondary) CASIN: INCOLS, 593555 Droso: INCOLS(593555 MonoLAsse: 0	Function of the set o	CHART CONTRACT CONTR			

• In vitro toxicity and toxicokinetic measurements are underway for ~150 PFAS [3]. These will be released in the future on the

Experimental property data are being harvested from literature and online resources to include into the dashboard and OPERA models. • Chemical categorization efforts continue in order to be encompassing of more of the PFAS library.

Mansouri et al. OPERA models for predicting physchem properties and environmental fate endpoints, *J. ChemInf.* **10**, 10 (2018) PFAS Categories list on the CompTox Chemicals Dashboard https://comptox.epa.gov/dashboard/chemical lists/EPAPFASCAT Patlewicz et al. A Chemical Category-Based Prioritization Approach for Selecting 75 Per- and Polyfluoroalkyl Substances (PFAS) for Tiered Toxicity and Toxicokinetic Testing. Environ Health Perspect. 2019 Jan;127(1):14501.

The authors thank the chemical curation team for their rigorous work and the software development team for the development of the dashboard.