Determination of Levels of Polychlorinated biphenyls (PCBs) present in Caulk and Window Glazing Material Samples from Older Buildings

Lantis I. Osemwengie, Ph.D.

Jade Morgan, MS.

Environmental Chemistry Branch

Environmental Sciences Division

National Exposure Research Laboratory

Office of Research and Development

Environmental Protection Agency

Las Vegas, Nevada 89119

United States Environmental Protection Agency

Objectives

- What are PCBs and Uses of PCBs
- The chemical structures of chlorinated biphenyls
- Why look for PCBs in caulks and glazing materials?
- Extraction of polychlorinated biphenyls (PCBs) from caulks and glazing materials
- PCBs Gas chromatographic analysis
- Results
- Summary and Conclusion

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What are Polychlorinated Biphenyls

- Ten homologs of compounds differing by the numbers of chlorines and hydrogens on a biphenyl ring
- They consist of mono, di, …, nona, and deca substituted chlorines in the ten groups.
- PCB mixtures made in Japan – “Kanechlor,” in Germany – “Chlophen,” in France – “Phenoclor.”
- Used in Capacitors, Transformers, Vacuum pumps, hydraulic fluids, cutting oil, lubricants, and plasticizers
- They are considered ubiquitous environmental pollutants – found in marine plant and animal specimens, fish, bird eggs, and humans (M.D. Erickson 1986)

Uses of PCB Mixtures

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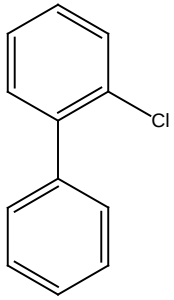
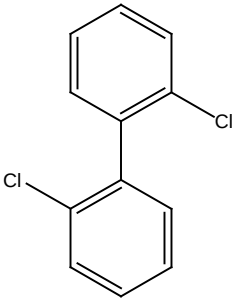
	Aroclor Mixtures								
Use of PCBs in:	1221	1232	1016	1242	1248	1254	1260	1262	1268
Capacitors	X		X	X		X			
Transformers				X		X	X		
Vacuum pumps					X	X			
Gas Transmission	X			X					
Hydrualic fliud		X		X	X	X	X		
Plasticizer in synthetic resins					X	X	X	X	X
Heat transfer fluids	X	X		X	X	X			X
Wax extenders				X					
Dusting agents				X		X			
Pesticides extenders						X	X		X

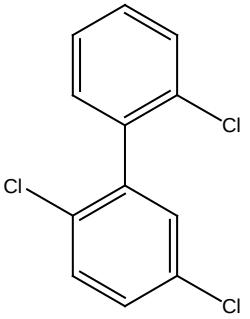
Chemical Structure of Each Class of Polychlorinated biphenyls



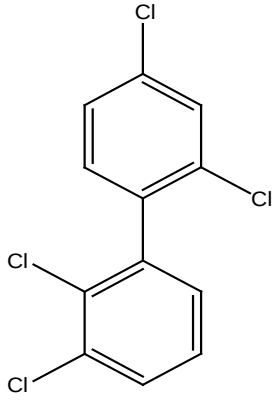
2-Chloro-biphenyl



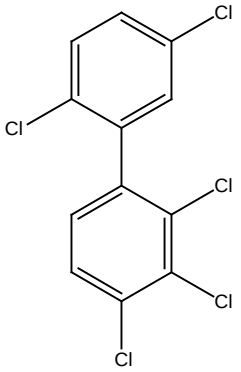
2,2'-Dichloro-biphenyl



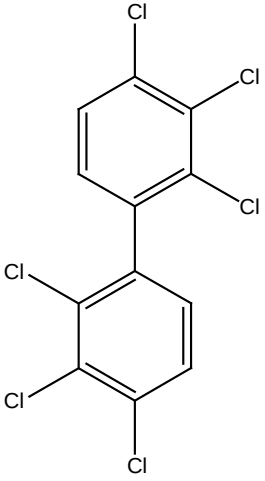
2,5,2'-Trichloro-biphenyl



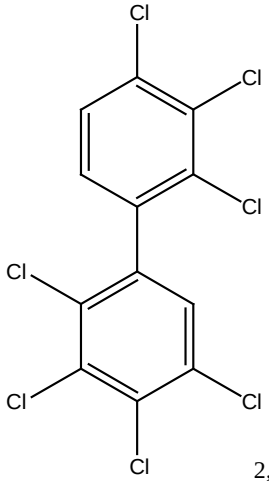
2,3,2',4'-Tetrachloro-biphenyl



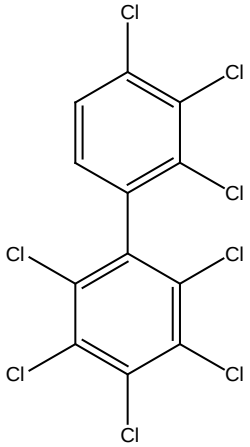
2,3,4,2',5'-Pentachloro-biphenyl



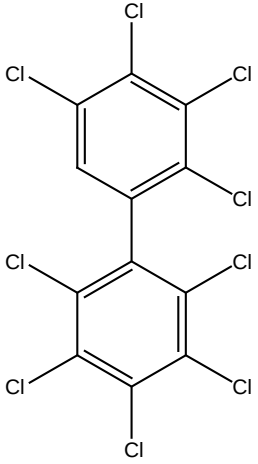
2,3,4,2',3',4'-Hexachloro-biphenyl



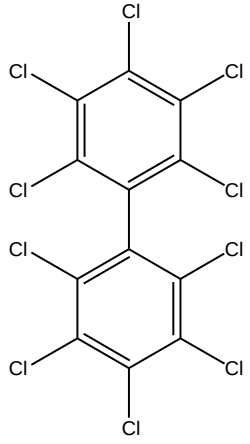
2,3,4,5,2',3',4'-Heptachloro-biphenyl



2,3,4,5,6,2',3',4'-Octachloro-biphenyl



2,3,4,5,6,2',3',4',5'-Nonachloro-biphenyl



2,3,4,5,6,2',3',4',5',6'-Decachloro-biphenyl

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Sources of PCBs

Conventional Sampling of PCBs in the Environment:

- Biological tissues
- Water
- Soils
- Dust Particles
- Air

Why look for PCBs in caulks and glazing materials?

- From 1950 to 1978, PCBs formulated-caulk (mostly polysulfides) was used in buildings, including schools[1]

- To improve risk, management decision, and help minimize human exposure to PCBs, information regarding the presence of PCBs in caulks in buildings became necessary

[1]T. Rantio, R. Riala, H. Kontsas and et al., Safe removal of PCB and lead containing elastic sealants in prefabricated houses (in Finnish). Finnish Institute of occupational Health 2001, 1- 63

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Extraction of PCBs in Caulks and Glazing Materials

- In the literature, analytical data that justified extraction efficacy of PCBs in caulks and glazing materials (Quality control data) are lacking
- Ease of sample extraction optimization, using Accelerated Solvent Extraction system, resulted in high-yield PCBs recoveries
- Flexible caulk samples were placed in dichloromethane while dried and flaky samples were placed in n-hexane/acetone mixture before extraction
- EPA method 608 gas chromatographic analysis method was adopted

Extraction of polychlorinated biphenyls (PCBs) from caulks and glazing materials

Caulks

Glazing materials

- Solvents: (Dichloromethane, 1:1 n-hexane and Acetone)
- ASE used for all PCBs extractions
- GPC Cleanup performed
- Sulfuric Acid washed

Numbers of Caulk and Glaze Materials Collected

	Schools			
	1	2	3	4
Sample Location Description	Number of Samples			
Exterior Caulk (EC)	3	2	2	3
Interior Caulk (IC)	7	4	4	0
Exterior Building Joint Caulk (EJ)	1	0	0	2
Interior Building Joint Caulk (IJ)	0	1	0	2
Window Glazing (WG)	3	0	1	1
Quality Control Samples				
Exterior Caulk (EC) duplicate	1	1	0	0
Interior Caulk (IC) duplicate	0	1	0	0
Window Glazing (WG) duplicate	0	0	1	1
Silicone caulk field blank	1	1	1	0
Acrylic latex with silicone field blank	1	1	1	0
Total Samples collected per school	17	11	10	9

Interior Caulk PCBs in ug/g

School	Sample Type	Dilution Factor	Concentration (µg/g)	Aroclor Type
1	IC-10	5	**< MDL	
1	IC-11	5	14.1	1254
1	IC-12	5	1220	1254
1	IC-13	100	161	1262
1	IC-14	5	16.5	1254
1	IC-15	40	90.5	1262
1	IC-16	10	13.6	1262
2	IC-10	50000	445,000	1254
2	IC-11	5	17.1	1016/1254 Mix
2	IC-12	1	4.41	1254
2	IC-12 (duplicate)	1	3.77	1254
2	IC-14	5	27.0	1248
3	IC-10	1	**< MDL	
3	IC-11	1	5.33	1254
3	IC-12	1	**< MDL	
3	IC-13	5	26.2	1242

**MDL = 1.2 µg/mL (3 times the signal to noise ratio)

Exterior Caulk PCBs in ug/g

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School	Sample Type	Dilution Factor	Concentration (µg/g)	Aroclor Type
1	EC-10	100	720	1242
1	EC-10 (duplicate)	200	663	1242
1	EC-11	1	8.45	1254
1	EC-12	5	7.32	1242
2	EC-10	500	997	1254
2	EC-11	30000	153,000	1254
2	EC-11 (duplicate)	10000	131,000	1254
3	EC-10	1	**< MDL	1262
3	EC-11	5	**< MDL	1254
4	EC-10	1	1.52	1254
4	EC-11	25	54.6	1254/1260 Mix
4	EC-12	1	**< MDL	

**MDL = 1.2 µg/mL (3 times the signal to noise ratio)

Exterior, Interior Joint Caulk and Windows Glazing PCBs in ug/g

School	Sample Type	Dilution Factor	Concentration (µg/g)	Aroclor Type
1	EJ-10	5	**< MDL	1242
2	IJ-10	1	10.3	1254
4	EJ-10	5	**< MDL	
4	EJ-11	40000	105,000	1262
4	IJ-10	5	27.5	1242
4	IJ-11	1	1.73	1254
4	WG-10	5	**< MDL	
4	WG-11 (duplicate)	1	**< MDL	
1	Field blank	5	**< MDL	

**MDL = 1.2 µg/mL (3 times the signal to noise ratio)

PCBs Average Percent Spike Recovery, Standard Deviation, and Relative Percent Difference

PCB Aroclor®	School ID	Sample Number	% Spike Recovery	Relative Standard Deviation	Relative % Difference
1254/1260	4	WG-10	66.2	4.8 (n=4)	13.3
1016/1254	3	WG-10	48.8	10.8 (n=7)	17.5
1248	1	EC-10 (dup)	54.9	3.3 (n=3)	10.9
1254	4	WG-11	66.6	8.3 (n=2)	17.6
1254	3	WG-10	97.0	28.0 (n=4)	20.1
1254	4	EC-12	103	34.0 (n=3)	11.1
1254	3	EC-10	137	10.7 (n=2)	11.2
1254	3	EC-11	100	13.0 (n=2)	18.4
1254	4	IJ-11	137	n/a (n=1)	n/a
1254	4	EC-10	171	n/a (n=1)	n/a

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Summary

- 37 caulk and windows glaze samples were analyzed
- Aroclors 1242, 1248, 1254, 1260, and 1262 were detected in most of the samples
- Levels of PCBs exceeding 50ug/g (54.6 to 445000ug/g) were detected in some of the caulk materials

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Conclusion

- The analytical method developed for caulk and glaze material in this study is an enhancement of U.S. EPA SW846 Method 8082A, extending its application to an additional matrix (cauks)
- The sample preparation, solvent extraction and cleanup methods used here provided reliable measurement results

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EPA's PCB Research

- PCBs in Caulk (1950 -78 buildings)
- Source migration path - air, dust, and soil in school buildings
- http://www.epa.gov/pcbsincaulk/caulkresearch.htm