

Research Article

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Polybrominated diphenyl ethers and Dechlorane Plus in soil from four different industry parks: identification, emission characteristics, spatial distribution, and health risk assessment

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Abstract

This study investigated the surface soil of four typical industrial parks involved in crude oil extraction, petroleum refining, and downstream petrochemical manufacturing processes to clarify the emission patterns of polybrominated diphenyl ethers (PBDEs) and Dechlorane Plus (DP) in various industrial areas and reveal their impact on the surrounding environment. The concentrations of PBDEs and DP in soil from a flameretardant manufacturing park were 1310³ and 110³ ng/g, respectively, far exceeding those in three petrochemical parks. Among the 20 PBDE congeners analyzed, BDE-209 and Deca-BDEs consistently exhibited the highest concentrations across all four sites. However, the relative compositions of syn-DP and anti-DP differed between the flameretardant manufacturing park and the petrochemical parks, with the flameretardant manufacturing park showing a higher anti-DP ratio.



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significantly lower than those in the three petrochemical parks. Horizontal spatial distribution of PBDEs and DPs revealed the presence of point source emission and demonstrated that chemical emissions from the parks influenced surrounding areas. A prolonged emission history contributed to the cumulative concentrations and distinctive composition profiles of these chemicals in soil. Dermal contact based on carcinogenic risk assessments indicated that the hazard indices for PBDEs in soil were below 1, suggesting an acceptable health risk. Among PBDE congeners, tri-BDEs contributed most significantly to non-carcinogenic risks, despite BDE20 being the most abundant. Non-carcinogenic risks associated with DPs were negligible across all four parks.

Keywords: Brominated flame retardant, chlorinated flame retardant, emission, petrochemical, industrial, risk assessment

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BDE13	n d	0 12	11 2	0 1	3 1	3 0110 ³	n d	n d	0	n d	n d	2 21
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BDE15	n d	0 13	3	0 2	20	3	n d	0 0	2 33	n d	n d	1 3
BDE1 3	n d	n d		2	33 0	5 10 ³	n d	n d	1 30	n d	n d	2 2
BDE1 0	n d	n d	0	0 21	10	150 ³	n d	n d	0 5	n d	n d	2 2
BDE1	n d	0 23	5 0	0 2	21 1	3 1 10 ³	n d	0 02	1 12	n d	n d	2 30
BDE1	n d	1 0		0 0	3	1 1 10	n d	0 11	3 2	n d	n d	2 1
BDE203	n d	0 0	15 0	0 5		2 10 ³	n d	0 0	1 3	n d	n d	3 01
BDE20	n d	0	1	2 1	1 1	2 5110	n d	n d	2 3	n d	0 15	2
BDE20	n d	2 2	1 5	3 5	1	1 10	n d	0 20		n d	0 15	2 1
BDE20	n d	0	22		1	1 2 10	n d	0 25	3	n d	n d	1 2
BDE20	n d	5 3	1 5	225	3 010 ³	1 10	n d	1 30	1 2	n d	0 5	32
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'3												
syn DP	n d	0 22	1 2	10 0	5	1 10	n d	n d	2 5	n d	n d	0 5
anti DP	n d	2 2	1	0 05	11	5 03 10 ³	n d	n d	3 3	n d	n d	1
³ DP	n d	2 5	5	10 1		5210	n d	n d	3	n d	0 02	2 23

PBDEsPolybrominateddiphenylethersDPs:DechloranePlusLPP1Lan hpetrochemicalark BFRPBFRmanufacturingark PP: angshapetrochemicalark JPPJieyangpetrochemicalark n hot detected

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Figure 1. Spatial distribution of PBDEs and DPs in parks and their surrounding areas. A and B: Lanqiao petrochemical park; C and D: BFR manufacturing park; E and F: Jangshan petrochemical park; and H: Jieyang petrochemical park. A, C, E, and H for PBDEs; B, D, F, and H for DPs. PBDEs: Polybrominated diphenyl ethers; DPs: Dechlorane Plus; BFR: brominated flame retardant.

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Figure 2. **Compositio** profiles of APBDEs and BDPs in soils sample from four industrial parks and their surrounding areas PBDEs: Polybrominated diphenyl ethers DPs: Dechlorane Plus LPP: Lan hou petrochemical park LPS: surrounding area of Lan hou petrochemical park BFRP: BFR manufacturing park BFRS: surrounding area of BFR manufacturing park

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*i re*Non-carcinogenic risks of PBDEs and DPs in four industrial areas through (A) oral intake and (B) dermal contact for both children and adults. PBDEs: Polybrominated diphenyl ethers; DPs: Dechlorane Plus; LPP: Lanzhou petrochemical park; LPS: surrounding area of the Lanzhou petrochemical park; BFRP: BFR manufacturing park; BFRS: surrounding area of the BFR manufacturing park.

*i re*Contribution of each component to the total HI values from oral ingestion and dermal contact. (A) Lanzhou petrochemical park; (B) BFR manufacturing park; (C) Tangshan petrochemical park; (D) Jieyang petrochemical park. HI: Hazard index; BFR: brominated flame retardant.

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