Supplementary Information

Emissions of volatile organic compounds from industrial sources and their effects on ozone formation in Wuhan, China

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NO. of Tables 6

content

Table S1 Detail information of nine vehicle-related and seven commodity
manufacturing industries
Table S2 Detail Information of the sixteen Sampling Sites
Table S3 OFP values of VOCs analogues emitted from vehicle-related industries 8
Table S4 OFP values of VOCs analogues emitted from commodity manufacturing industries
Table S5 OFP of twenty-seven detectable VOC analogues from nine vehicle-related and seven commodity manufacturing industries
Table S6 The detection concentrations of individual forty-eight VOCs Emitted by sixteen Industries

Table S1 Detail information of nine vehicle-related and seven commodity manufacturing industries

Factor	Industry Category	Annual Production	raw and auxiliary materials that	VOCs-Involved Process	VOCs Emission during the
У		Capacity	generate VOCs and their production	(Pollutant Category)	Production Process (kg)
			volumes		and the Corresponding
					Year
DFFS	Automobile	3,510,000 vehicles	Water-based 3C1B Compact Coating	Industrial coating, Drying	Non-Methane
	manufacturing of		Line (120,000 units)	(VOCs, Sulfur Dioxide,	Hydrocarbons
	complete vehicles			Nitrogen Oxides,	2019:120
				Particulate Matter,	
				Benzene, Toluene, Xylene,	
				Non-Methane	
				Hydrocarbons)	
DFSC	Manufacturing of	120000 units	Electrophoretic primer (632.846 t),	Spraying, Drying (VOCs,	VOCs
	complete gasoline		Sealant (773.988 t), Paint (298.1 t),	Particulate Matter,	2019:120212.03
	and diesel vehicles		Clear coat (116.715 t)	Toluene, Xylene)	2020 : 224066.85
DFYC	Manufacturing of	304231 units	Electrophoretic primer (2263.662 t),	Spraying, Drying (VOCs,	VOCs
	complete gasoline		Sealant (2560.059 t)	Particulate Matter,	2019:407387.6
	and diesel vehicles		Intermediate coating (601.961 t), Paint	Toluene, xylene)	2020 : 189321
			color (825.397 t), Clear coat (399 t)		
SLSC	Manufacturing of	31889 vehicles	Electrophoretic pigment slurry (35.848	Coating (Non-Methane	VOCs
	complete gasoline		t), Electrophoretic resin (145.211 t),	Hydrocarbons, Toluene,	2019:65049
	and Diesel vehicles		Electrophoretic solvent (4.6 t), Sealant	Xylene, Sulfur Dioxide,	2020 : 58272
			(78.5 t), Seal PVC coating (61.5 t),	Nitrogen Oxides,	
			Undercoat paint (29.695 t), Paint	Particulate Matter)	
			(109.454 t), Clear coat (40.228 t),		
			Curing agent (15.146 t), Repaired paint		

			(0.032 t), Repaired clear coat (0.04 t), Repaired curing agent (0.009 t), Cleaned butyl acetate (23.267 t), Cleaned water-based solvents (6.847		
			t)		
LY	Manufacturing of	Bumper 72,800 pieces	Thermoplastics and thermosets (1459	Surface coating (Benzene,	VOCs: 116595
	automotive parts and		t), Undercoat (15.39 t), Paint (49.38 t),	Toluene, Xylene)	
	accessories		Clear coat (38.63 t), Varnish (48.98 t),		
			Cleaning solvent (53.14 t)		
DFADT	Manufacturing of	500,000 vehicles	Foaming agent, Adhesive, Paint	Coating (Benzene, Toluene,	VOCs
	automotive seat			Xylene)	
	assemblies and				
	related components				
DFEC	Manufacturing of	319665 units	Sealant (2803.56 t), Cathodic	Spraying, Drying (VOCs,	VOCs
	complete gasoline		electrophoretic paint (2204.82 t), Paint	Particulate Matter,	2019:452906.89
	and diesel vehicles		(1062.54 t), Clear coat (374.54 t),	Toluene, Xylene)	2020: 182370.69
			Solvent (50.37 t), Cleaning agent		
			(104.68 t)		
GM	Manufacturing of	-	Injection molding raw materials	Coating, Welding (Benzene,	VOCs
	non-metallic interior			Toluene, Xylene)	
	and exterior trim				
	parts and structural				
	components for				
	automobiles				
VSKT	Manufacturing of	3 million units of	Cutting fluid (135 t)	Sand core baking (Non-	Non-
	automobile parts	automotive exhaust		Methane Hydrocarbons)	Methane Hydrocarbons

		manifold and			2020: 0.29mg
		turbocharger housing			
MXDZ	Electronic circuit	Rigid printed circuit	Ink (386.1 t), Cleaning agent, Diluent	Printing (Non-Methane	Non-
	manufacturing	boards 4,560,000 m ³	(70.6 t)	Hydrocarbons)	Methane Hydrocarbons
	industry				2019:21590
					2020: 14040
ZL	Packaging and	10 billion cans	Clear varnish (194 t), Ink (44 t),	Color printing drying,	Non-
	Printing industries	(Aluminum cans)	Internal coating (575 t)	Internal coating drying, Gas	Methane Hydrocarbons
				emission (Non-	2019:845
				Methane Hydrocarbons,	2020: 2400
				Formaldehyde)	Formaldehyde
					2019:134
					2020:0
JC	Foam plastic	4000 t	LDPE pellets (3000 t), Butane (175 t)	Extrusion (Non-	VOCs
	manufacturing			Methane Hydrocarbons)	2019: 2100
					2020: 1929.6
BD	Manufacturing of	-	Coating, Adhesives, Plastic materials	Injection molding,	Non-Methane
	dance equipment			Extrusion, Printing, Spray	Hydrocarbons
				coating, Bonding (Non-	
				Methane Hydrocarbons,	
				Benzene, Toluene, Xylene)	
CLBL	Glass manufacturing	500,000 t	Ink, Adhesive, Fuel, Sealant, Paint	Printing, Interlayer curing,	Non-Methane
	industry			Melting furnace	Hydrocarbons
				combustion (VOCs,	VOCs
				Formaldehyde, Non-	
				Methane Hydrocarbons)	

НВ		Steel bridge structure	Epoxy primer, Intermediate coating,	Spraying (Xylene)	VOCs
		55,000 t	Topcoat, Benzene-free thinner, Acrylic		31560
			thinner		
HJL	Packaging decoration	1.5 million cases of	Alcohol-soluble intaglio ink (333.4 t),	Mixing the ink, Printing,	VOCs
	and other printing	cigarette outer	Intaglio solvent ink (67 t), Screen	Cleaning (Volatile Organic	2019:150220
	industries	packaging printed	printing UV ink (12 t), Offset printing	Compounds, Benzene,	2020: 109560
		products	UV ink (22 t), Water-based UV varnish	Toluene, Xylene)	
			(6.6 t), Ethyl acetate (5 t), Propyl		
			acetate (170 t), Cleaning agent (55 t),		
			Wetting solution (1.5t)		

Table S2 Detail Information of the sixteen Sampling Sites

				Operation Status of nearby
	Tempruture (°C)	Weather	Wind Direction	Industries
DFFS	25~34	light rain	Southwest	In Operation
DFSC	25~34	light rain	Southwest	In Operation
DFYC	25~34	light rain	Southwest	In Operation
SLSC	25~27	heavy rain	West	In Operation
LY	25~33	moderate rain	South	In Operation
DFADT	25~34	light rain	Southwest	In Operation
DFEC	25~34	light rain	Southwest	In Operation
GM	25~27	heavy rain	West	In Operation
VSKT	25~31	moderate rain	South	In Operation
MXDZ	25~34	light rain	Southwest	In Operation
ZL	25~33	moderate rain	South	In Operation
JC	25~27	heavy rain	West	In Operation
BD	25~33	moderate rain	South	In Operation
CLBL	25~27	heavy rain	West	In Operation
НВ	25~27	heavy rain	West	In Operation
HJL	25~31	moderate rain	South	In Operation

Table S3 OFP values of VOCs analogues emitted from vehicle-related industries

\(\(\text{OC}_2\) = \(\text{ond}_2\) = \(\text{on}_2\)	Minimum	Maximum	Medians	Average	Duan autian
VOCs analogous	(ug/m³)	(ug/m³)	(ug/m³)	(ug/m³)	Proportion
1,3,5-Trimethylbenzene	0.3	260.5	1.0	60.0	27.3%
o-Xylene	2.5	224.5	12.4	54.9	25.0%
1,2,4-Trimethylbenzene	0.1	170.4	5.8	40.2	18.3%
m+p-Xylene	0.2	95.7	2.8	17.3	7.9%
sec-Butylbenzene	0.1	59.0	4.4	15.6	7.1%
2-Chlorotoluene	0.4	53.7	7.8	14.1	6.4%
p-Cymene	<0.1	53.9	0.8	10.5	4.8%
tert-Butylbenzene	< 0.1	6.3	0.7	2.2	1.0%
Isopropylbenzene	< 0.1	9.5	0.2	1.6	0.7%
Butylbenzene	<0.1	4.8	0.4	1.3	0.6%
trans-1,3-Dichloropropene	0.3	3.8	0.7	1.3	0.6%
Styrene	< 0.1	3.4	0.1	0.7	0.3%
Benzene	<0.1	0.3	<0.1	0.1	<0.1%
cis-1,3-Dichloropropene	<0.1	0.1	<0.1	<0.1	<0.1%
1,1,2-Trichloroethane	< 0.1	0.1	<0.1	<0.1	<0.1%
1,2-Dichloropropane	< 0.1	0.1	<0.1	<0.1	<0.1%
Propylbenzene	< 0.1	0.1	<0.1	<0.1	<0.1%
1,1-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1%
Tetrachloroethene	<0.1	<0.1	<0.1	<0.1	<0.1%
Total	5.3	646.8	55.9	219.7	

Table S4 OFP values of VOCs analogues emitted from commodity manufacturing industries

	Minimum	Maximum	Medians	Average	Droportion
VOCs analogous	(ug/m³)	(ug/m^3)	(ug/m³)	(ug/m³)	Proportion
trans-1,3-Dichloropropene	<0.1	14.5	0.5	3.1	42.2%
o-Xylene	0.6	5.8	1.7	2.6	36.4%
1,3,5-Trimethylbenzene	<0.1	1.0	0.5	0.5	6.3%
m+p-Xylene	<0.1	1.1	0.2	0.4	4.8%
Butylbenzene	< 0.1	1.4	<0.1	0.2	2.7%
1,2,4-Trimethylbenzene	<0.1	0.5	0.1	0.2	2.4%
2-Chlorotoluene	<0.1	0.5	<0.1	0.2	2.1%
sec-Butylbenzene	<0.1	0.3	0.1	0.1	1.7%
tert-Butylbenzene	<0.1	0.4	<0.1	0.1	0.8%
Benzene	<0.1	0.1	<0.1	<0.1	0.5%
Isopropylbenzene	<0.1	<0.1	<0.1	<0.1	0.1%
1,1-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1%
1,1,2-Trichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1%
Tetrachloroethene	<0.1	<0.01	<0.1	<0.1	<0.1%
Total	1.1	17.4	4.2	7.3	

Table S5 OFP of twenty-seven detectable VOC analogues from nine vehicle-related and seven commodity manufacturing industries

VOCs analogous	DFFS	DFSC	DFYC	SLSC	LY	DFADT	DFEC	GM	VSKT	MXDZ	ZL	JC	BD	CLBL	НВ	HJL
0-Xylene	4.9	27.9	12.4	36.1	176.9	2.5	5.1	224.5	3.9	1.4	5.8	0.6	1.7	1.6	2.4	4.9
sec-Butylbenzene	1.1	38.8	4.4	28.9	59.0	0.1	0.4	7.0	0.6	0.2	0.1	<0.1	-	0.1	0.1	0.3
1,3,5-Trimethylbenzene	21.8	4.2	0.3	1.0	249.7	1.0	0.6	260.5	1.0	0.1	1.0	-	0.8	-	0.5	0.7
1,2,4-Trimethylbenzene	5.8	170.4	21.6	127.0	1.1	0.1	1.9	31.7	2.5	0.1	-	-	-	0.4	0.5	0.2
p-Cymene	0.8	53.9	4.2	29.6	-	-	0.4	4.8	0.6	-	-	-	-	-	-	-
m+p-Xylene	0.7	4.0	2.8	7.8	42.7	0.2	1.1	95.7	0.3	0.2	0.6	<0.1	0.1	0.2	0.3	1.1
tert-Butylbenzene	0.1	6.1	0.7	6.3	4.7	-	-	1.4	-	-	-	-	-	-	-	0.4
Isopropylbenzene	<0.1	0.8	0.2	0.9	9.5	0.2	0.1	2.7	-	<0.1	<0.1	<0.1	-	-	<0.1	-
Butylbenzene	0.1	4.8	0.4	3.0	2.8	-	-	0.4	-	1.4	-	-	-	-	-	-
Styrene	<0.1	0.2	0.1	0.3	3.4	-	<0.1	1.9	-	-	=	-	-	-	-	-
Benzene	<0.1	<0.1	<0.1	0.1	<0.1	0.3	0.1	<0.1	<0.1	<0.1	0.1	0.1		<0.1	<0.1	<0.1
Propylbenzene	-	0.1	-	ı	-	-	ı	-	-	-	=	-	-	-	-	-
2-Chlorotoluene	1.5	53.7	7.7	31.5	16.2	0.4	0.7	14.3	1.1	-	0.5	-	0.3	<0.1	-	0.3
1,2,3-Trichlorobenzene	-	-	ı	ı	-	-	ı	-	-	-	-	-	-	-	-	-
1,2,3-Trichloropropane	-	-	ı	ı	-	-	ı	-	-	-	-	-	-	-	-	-
1,2-Dibromo-3-chloropropane	-	-	ı	ı	-	-	ı	-	-	-	-	-	-	-	-	-
Bromodichloromethane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	-	-	<0.1	<0.1	<0.1	-	ı	-	-	<0.1	-	-	-	<0.1	<0.1	<0.1
1,2-Dichloropropane	-	-	-	ı	-	-	ı	0.1	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	<0.1	<0.1	-	0.1	-	<0.1	<0.1	<0.1	-	<0.1	-	-	-	-	=	-
1,1,2,2-Tetracholoethane	-	-	-	1	-	-	-	-	-	-	-	-	-	-	=	-
trans-1,3-Dichloropropene	0.3	0.4	1.2	0.7	2.3	0.5	0.5	1.7	3.8	-	4.9	0.3	14.5	0.5	0.4	0.8

Tetrachloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachloro-1,3-butadiene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloropropene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	-	-	-	-	0.1	-	0.1	-	-	-	-	-	-	-	-	-
Chlorodibromomethane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table S6 The detection concentrations of individual forty-eight VOCs Emitted by sixteen Industries

Test Item	DFFS	DFSC	DFYC	SLSC	LY	DFAD	DFEC	GM	VSKT	MXD	ZL	JC	BD	CLBL	НВ	HJL
						Т				Z						
trans-1,2-	n.d.															
Dichloroethene																
1,1-Dichloroethene	n.d.	n.d.	<0.01	<0.01	0.60	n.d.	n.d.	n.d.	n.d.	<0.01	n.d.	n.d.	n.d.	<0.01	<0.01	0.20
cis-1,2-Dichloroethane	n.d.															
Bromochloroethene	n.d.															
Chloroform	n.d.															
1,1,1-Trichloroethene	n.d.															
1,1-Dichloropropene	n.d.	n.d.	n.d.	<0.01	n.d.	n.d.	n.d.	0.10	n.d.	n.d.	n.d.	n.d.	0.10	n.d.	n.d.	n.d.
1,2-Dichloroethene	n.d.															
Benzene	<0.01	<0.01	<0.01	0.10	<0.01	0.40	0.10	<0.01	<0.01	<0.01	0.10	0.10	n.d.	<0.01	<0.01	0.10
Trichloroethene	n.d.															
1,2-Dichloropropane	n.d.	0.40	n.d.													
Methylene_bromide	n.d.															
Bromodichloromethane	n.d.	n.d.	<0.01	n.d.	n.d.	n.d.	n.d.	0.50	n.d.	0.60	n.d.	n.d.	<0.01	n.d.	n.d.	n.d.
cis-1,3-Dichloropropene	n.d.	n.d.	n.d.	n.d.	<0.01	n.d.	<0.01	n.d.								
Toluene	n.d.															
trans-1,3-	0.10	0.10	0.20	0.10	0.50	0.10	0.10	0.30	0.70	n.d.	1.00	<0.01	2.90	0.10	0.10	0.20
Dichloropropene																
1,1,2-Trichloroethane	<0.01	<0.01	n.d.	1.50	n.d.	<0.01	0.30	0.10	n.d.	0.10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1,3-Dichloropropane	n.d.															
Tetrachloroethene	<0.01	<0.01	<0.01	<0.01	<0.01	n.d.	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorodibromomethan	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	<0.01	n.d.								

е																
1,2-Diromoethane	n.d.															
Chlorobenzene	n.d.															
1,1,1,2-	n.d.															
Tetrachloroethane																
Ethylbenzene	n.d.															
m+p-Xylene	0.10	0.50	0.40	1.00	5.50	<0.01	0.10	12.30	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	<0.01	0.10
0-Xylene	0.60	3.70	1.60	4.70	23.20	0.30	0.70	29.40	0.50	0.20	0.80	0.10	0.20	0.20	0.30	0.60
Styrene	<0.01	0.10	<0.01	0.20	2.00	n.d.	<0.01	1.10	n.d.							
Bromoform	n.d.															
Isopropylbenzene	<0.01	0.30	0.10	0.40	3.80	0.10	<0.01	1.10	n.d.	<0.01	<0.01	<0.01	n.d.	n.d.	<0.01	n.d.
1,1,2,2-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.10	<0.01	n.d.	n.d.	n.d.	0.10	n.d.	n.d.	n.d.	n.d.
Tetracholoethane																
Bromobenzene	n.d.															
1,2,3-Trichloropropane	0.40	0.40	19.00	25.20	0.70	n.d.	n.d.	0.20	<0.01	0.30	17.50	n.d.	<0.01	n.d.	n.d.	<0.01
Propylbenzene	n.d.	0.10	n.d.													
2-Chlorotoluene	0.50	18.40	2.70	10.80	5.50	0.10	0.20	4.90	0.40	n.d.	0.20	n.d.	0.10	<0.01	n.d.	0.10
1,3,5-Trimethylbenzene	1.90	0.40	<0.01	0.10	21.20	0.10	<0.01	22.20	0.10	<0.01	0.10	n.d.	0.10	n.d.	<0.01	0.10
tert-Butylbenzene	0.10	3.10	0.40	3.30	2.40	n.d.	n.d.	0.70	n.d.	0.20						
1,2,4-Trimethylbenzene	0.70	19.20	2.40	14.30	0.10	<0.01	0.20	3.60	0.30	<0.01	n.d.	n.d.	n.d.	0.10	0.10	<0.01
sec-Butylbenzene	0.50	16.50	1.90	12.30	25.00	<0.01	0.20	3.00	0.20	0.10	<0.01	<0.01	n.d.	0.10	<0.01	0.10
1,3-Dichlorobenzene	n.d.															
p-Cymene	0.20	12.10	0.90	6.70	n.d.	n.d.	0.10	1.10	0.10	n.d.						
1,4-Dichlorobenzene	n.d.															
1,2-Dichlorobenzene	n.d.															

Butylbenzene	<0.01	2.20	0.20	1.30	1.30	n.d.	n.d.	0.20	n.d.	0.60	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1,2-Dibromo-3-	n.d.	0.90	n.d.	0.70	7.90	n.d.	n.d.	0.20	n.d.							
chloropropane																
1,2,4-Trichlorobenzene	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Hexachloro-1,3-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.20	n.d.	n.d.	n.d.	n.d.	n.d.
butadiene																
Naphthalene	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1,2,3-Trichlorobenzene	n.d.	n.d.	n.d.	n.d.	0.10	n.d.	0.10									