



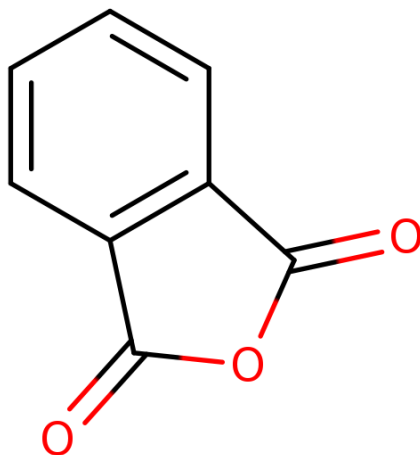
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Pollution Prevention

# Draft Physical Chemistry and Fate and Transport Assessment for Phthalic Anhydride

## Technical Support Document for the Draft Risk Evaluation

CASRN 85-44-9



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## 144 KEY ABBREVIATIONS AND ACRONYMS

145	BAF	Bioaccumulation factor
146	BCF	Bioconcentration factor
147	CASRN	Chemical Abstracts Service Registry Number
148	CFR	Code of Federal Regulations
149	cP	Centipoise
150	CSTR	Continuously Stirred Tank Reactor
151	DOE	Department of Energy (U.S.)
152	DRE	Destruction and removal efficiency
153	EPA	Environmental Protection Agency (U.S.)
154	EPI	Estimation Programs Interface
155	HLC	Henry's Law constant
156	log K <sub>AW</sub>	Logarithmic air:water partition coefficient
157	log K <sub>OA</sub>	Logarithmic octanol:air partition coefficient
158	log K <sub>OC</sub>	Logarithmic organic carbon:water partition coefficient
159	log K <sub>OW</sub>	Logarithmic octanol:water partition coefficient
160	NCBI	National Center for Biotechnology Information
161	NCI	National Cancer Institute
162	NIOSH	National Institute for Occupational Safety and Health
163	NIST	National Institute of Standards and Technology

164	NLM	National Library of Medicine
165	OECD	Organisation for Economic Co-operation and Development
166	·OH	Hydroxyl radical
167	pKa	Acid dissociation constant
168	POTW	Publicly owned treatment works
169	QSPR	Quantitative structure-property relationship
170	RSC	Royal Society of Chemistry
171	t <sub>1/2</sub>	Half-life
172	TRI	Toxics Release Inventory
173	TSCA	Toxic Substances Control Act
174	U.S.	United States
175	WWTP	Wastewater treatment plant
176		

## SUMMARY

This technical support document (TSD) is part of the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e) conducted under the Toxic Substances Control Act (TSCA) (see also public docket, EPA-HQ-OPPT-2018-0459). The U.S. Environmental Protection Agency (EPA or the Agency) collected and evaluated physical and chemical property data and information from trusted data sources as described in the *Draft Systematic Review Protocol for Phthalic Anhydride* (U.S. EPA, 2026f). Trusted sources are databases of curated, peer-reviewed data that can be considered high-quality (U.S. EPA, 2021). During the evaluation of phthalic anhydride, EPA considered the best available measured and estimated physical and chemical property information (see Table 2-1). Information on the full dataset is available in the *Draft Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for Phthalic Anhydride* (U.S. EPA, 2026c).

Phthalic anhydride is a white solid with the melting and boiling points of 130.8 °C and 284.05 °C, respectively (NIST, 2022; DOE, 2016). Phthalic anhydride has a water solubility of 6,200 mg/L at 24 °C (U.S. EPA, 2019a) and is expected to rapidly hydrolyze to *o*-phthalic acid in the presence of water. *o*-Phthalic acid is a white solid with the melting and boiling points of 206.75 °C and 324.85 °C, respectively (NCBI, 2020b; Booth et al., 2012). *o*-Phthalic acid has a water solubility of 6,994 mg/L at 24 °C (U.S. EPA, 2020b) and a Log K<sub>OW</sub> of 0.73 (U.S. EPA, 2020b). With a vapor pressure of 6.36×10<sup>-7</sup> mmHg at 25 °C (U.S. EPA, 2020b), *o*-phthalic acid is not expected to volatilize from dry, non-adsorbing surfaces. The selected Henry's Law constant for *o*-phthalic acid is less than 1×10<sup>-10</sup> atm·m<sup>3</sup>/mol at 25 °C (U.S. EPA, 2012), indicating that it is not expected to volatilize from water.

In this draft TSD, EPA evaluated the reasonably available information to characterize the physical-chemical properties of phthalic anhydride and *o*-phthalic acid. Upon release, phthalic anhydride is expected to rapidly hydrolyze to *o*-phthalic acid in the environment. Therefore, EPA focused on the environmental fate and transport of *o*-phthalic acid. The key points of this draft assessment are summarized below.

Given the consistent results from numerous high-quality studies, there is robust evidence that *o*-phthalic acid is

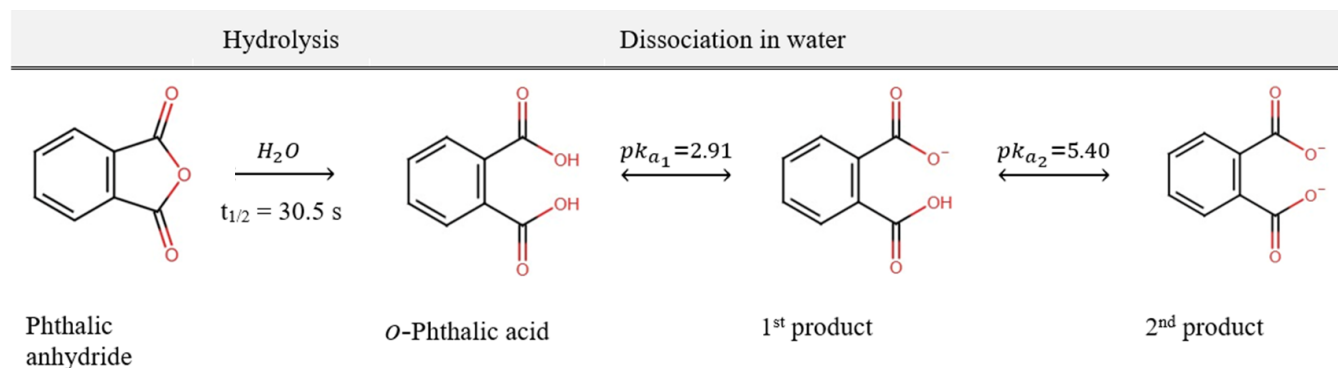
- expected to have negligible sorption to soil and sediment and rapidly migrate to groundwater and surface water (Section 3.1).
- expected to have high mobility within surface water and groundwater (Section 3.1).
- not expected to be subject to long range transport within ambient air (Section 3.1.2).
- expected to mainly partition to surface and groundwater, when released into the environment (Section 3.2.1).
- expected to transform in the environment (half-life [t<sub>1/2</sub>] on the order of days to weeks) via biotic and abiotic processes and ultimately biodegrade to form CO<sub>2</sub> and/or CH<sub>4</sub> (Section 4).
- expected to have an environmental biodegradation half-life in aerobic environments on the order of days to weeks (Section 4.1).
- expected to undergo significant indirect photolysis (Section 4.2).
- expected to be found as particles or dust (Section 5.1.1).
- expected to be subject to wet and dry deposition.
- not expected to be effectively removed in conventional drinking water treatment systems via sorption to suspended organic matter and filtering media (Section 6).
- not bioaccumulative in fish in the water column (Section 7).

EPA expects that *o*-phthalic acid will be removed at rates between 10 and 20% in conventional

224 wastewater treatment systems with aerobic biological treatment processes (Section 6.2).  
225

## 1 INTRODUCTION

Phthalic anhydride is a white solid with a total annual U.S. production volume between 500 and 750 million pounds (lb) (U.S. EPA, 2020a). It is highly reactive with water and is found under artificial conditions devoid of moisture. In the environment, phthalic anhydride rapidly hydrolyzes to 1,2-benzenedicarboxylic acid (Figure 1-1)—also known as *ortho(o)*-phthalic acid (*o*-phthalic acid). The hydrolysis half-life is estimated to be between 30 to 90 seconds in surface water, depending on pH, with complete hydrolysis in approximately 8 minutes in simulated seawater or physiological fluids (Andres et al., 2001). Within the atmosphere, the rate of hydrolysis is directly influenced by atmospheric conditions such as humidity and temperature and is generally assumed to occur on the order of minutes. However, phthalic anhydride industrial processes require dry and well-ventilated environments and is expected to persist longer under industrial settings. However, phthalic anhydride is also expected to occur in the environment as *o*-phthalic acid.



**Figure 1-1. General Illustration of Phthalic Anhydride Rapid Hydrolysis and Expected Dissociation of *o*-Phthalic Acid in Water**

This assessment was conducted to determine which environmental pathways to consider for the draft risk evaluation of phthalic anhydride. Details on the environmental partitioning and media assessments can be found in Section 5. Based on the reported rapid hydrolysis, phthalic anhydride will rapidly transform to *o*-phthalic acid in the environment. EPA anticipates *o*-phthalic acid to predominantly be found in water and groundwater. Based on the physical and chemical properties of *o*-phthalic acid as well as the releases to both air and water reported in TRI (U.S. EPA, 2026d) and the Draft *Environmental Release and Occupational Exposure Assessment for Phthalic Anhydride* (U.S. EPA, 2026d), *o*-Phthalic acid in water is mostly attributable to discharges from industrial and municipal wastewater treatment plant effluent, surface water runoff, and, to a lesser degree—atmospheric deposition. Once in water, *o*-phthalic acid is expected to primarily remain in water and have limited partitioning to suspended organic matter and aquatic sediments. *o*-Phthalic acid in soils is attributable to deposition from air and land application of biosolids. Due to its water solubility and low sorption to soils and sediments (log  $K_{ow}$  and log  $K_{oc}$ ), *o*-phthalic acid is expected to rapidly migrate to groundwater and surface water.

## 2 APPROACH AND METHODOLOGY FOR THE ASSESSMENT OF PHYSICAL AND CHEMICAL PROPERTIES

EPA performed a systematic review by conducting a literature search to find published physical and chemical property values available through 2020. Physical and chemical property data were extracted and evaluated for use in the risk evaluation as described in the *Draft Systematic Review Protocol for Phthalic Anhydride* (U.S. EPA, 2026f). Due to the large quantity of available data, only studies with an overall data quality ranking of high and medium were selected for use in determining the representative physical-chemical properties of phthalic anhydride and its hydrolysis byproduct *o*-phthalic acid for the purposes of the risk evaluation. The data points closest to the arithmetic mean were selected as the most robust and most reasonably achievable reported values. Because experimentally derived values for a log  $K_{OA}$  were not available, EPI Suite<sup>TM</sup> was used to estimate a value (U.S. EPA, 2017).

### 2.1 Select Physical and Chemical Property Values for Phthalic Anhydride and *o*-Phthalic Acid

**Table 2-1. Select Physical and Chemical Property Values for Phthalic Anhydride and *o*-Phthalic Acid**

Property	Phthalic Anhydride Selected Value(s)	<i>o</i> -Phthalic Acid Selected Value(s)	Reference(s)	Overall Data Quality Rating
Molecular formula	C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>		
Molecular weight	148.11 g/mol	166.13 g/mol		
Physical form	colorless to white lustrous solid	white crystals or fine white powder	<a href="#">Elsevier (2020)</a> ; <a href="#">NCBI (2020a)</a>	High
Melting point	130.8 °C	206.75 °C	<a href="#">DOE (2016)</a> ; <a href="#">Booth et al. (2012)</a>	High
Boiling point	284.05 °C	324.85 °C	<a href="#">NIST (2022)</a> ; <a href="#">NCBI (2020b)</a>	High
Density	1.527 g/cm <sup>3</sup>	1.593 g/cm <sup>3</sup>	<a href="#">NCBI (2020b)</a> ; <a href="#">Elsevier (2019)</a>	High
Vapor pressure	5.17×10 <sup>-4</sup> mmHg at 25 °C	6.36×10 <sup>-7</sup> mmHg at 25 °C	<a href="#">U.S. EPA (2020b)</a> ; <a href="#">NLM (2015)</a>	High
Vapor density	5.1 at 25 °C	5.7 at 25 °C	<a href="#">NCBI (2020b, 2020c)</a>	High
Water solubility	6,200 mg/L at 25 °C	6,994 mg/L at 25 °C	<a href="#">U.S. EPA (2020b, 2019a)</a>	High
Octanol/water partition coefficient (Log $K_{OW}$ )	1.43	0.73	<a href="#">U.S. EPA (2020b)</a> ; <a href="#">Elsevier (2019)</a>	High
Octanol/air partition coefficient (Log $K_{OA}$ )	5.656	11.120	<a href="#">U.S. EPA (2017)</a>	High
Henry's Law constant	1.70×10 <sup>-8</sup> atm·m <sup>3</sup> /mol at 25 °C	<1×10 <sup>-10</sup> atm·m <sup>3</sup> /mol at 25 °C (calculated from VP/WS)	<a href="#">NCBI (2020a)</a> ; <a href="#">U.S. EPA (2012)</a>	Medium
Flash point	152 °C	168 °C	<a href="#">Rumble (2018b)</a>	High
Autoflammability	584 °C	N/A	<a href="#">Park and Sheehan (2000)</a>	High
Viscosity	1.125 cP (155 °C)	N/A	<a href="#">NCBI (2020a)</a>	High

Property	Phthalic Anhydride Selected Value(s)	<i>o</i> -Phthalic Acid Selected Value(s)	Reference(s)	Overall Data Quality Rating
Dissociation constants (pKa)	N/A	pka <sub>1</sub> = 2.91 pka <sub>2</sub> = 5.399	<a href="#">Tummanapelli and Vasudevan (2015)</a> ; <a href="#">Partanen and Covington (2006a)</a>	High
cP = centipoise; VP/WS = vapor pressure and water solubility Note: A literature search for phthalic anhydride and phthalic acid was completed in 2025. However, EPA had gathered sufficient information in 2020 on the physical- chemical properties to support the risk evaluation and did not screen the peer-reviewed literature from the updated peer-reviewed literature search performed in February 2025.				

## 2.2 Endpoint Assessments

### 2.2.1 Melting Point

The melting point is one of the inherent properties that informs the chemical's physical state (liquid or solid) at normal environmental conditions. The melting point is the temperature at which a chemical substance coexists as its solid and liquid forms in equilibrium under atmospheric pressure (1 atmosphere) ([Rumble, 2021](#)). Physical state information helps assessors understand the environmental fate and transport as well as the chemical substance's potential exposure routes and bioavailability to aquatic organisms and humans (occupational and general population). EPA extracted a total of 12 overall high-quality, trusted data sources for phthalic anhydride and 8 for *o*-phthalic acid. These trusted data sources provided a robust weight of evidence supporting the melting point information for phthalic anhydride and *o*-phthalic acid. The closest melting point value to the mean of the identified information from the overall high-quality trusted data sources was selected as the representative melting point for each substance. These are summarized in Table 2-2 and discussed in detail on Sections 2.2.1.1 and 2.2.1.2 for phthalic anhydride and *o*-phthalic acid, respectively.

In summary, EPA selected the melting point values of 130.8 °C and 206.75 °C for phthalic anhydride and *o*-phthalic acid, respectively. At environmental temperatures and conditions both compounds are expected to be present as solids, as indicated by their melting points and boiling point (284.05 °C for phthalic anhydride and 324.85 °C for *o*-phthalic acid) and may be present as suspended particles in air. However, a solid particle of suspended phthalic anhydride will rapidly interact with available water molecules within the atmosphere and completely hydrolyze to a solid particle of *o*-phthalic acid in ambient air on the order of minutes.

**Table 2-2. Summary of Available Melting Point Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	12	8
Data points	21	9
Mean	130.6 °C	206.86 °C
Standard deviation	1.71 °C	11.55 °C
Minimum	125 °C	191 °C
Maximum	132.35 °C	230 °C
Selected value	130.8 °C ( <a href="#">DOE, 2016</a> )	206.75 °C ( <a href="#">Booth et al., 2012</a> )

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Selection rationale	Reported value is closest to the mean of the reported values within the available high-quality sources under normal environmental conditions	
Confidence level	Robust	Robust

### 2.2.1.1 Phthalic Anhydride

The available high-quality trusted data sources reported melting points ranging from 125 to 132.35 °C for phthalic anhydride (>99% purity) ([NIST, 2022](#); [U.S. EPA, 2019a](#); [Rumble, 2018c](#); [DOE, 2016](#); [O'Neil, 2013](#); [NIOSH, 2007](#); [OECD, 2005](#); [Ohm, 2000](#); [Park and Sheehan, 2000](#); [Das et al., 1979](#); [NCI, 1979](#); [Monroe, 1920](#)). The mean and standard deviation of the reported melting point values within these sources are 130.6 °C and 1.71 °C, respectively. EPA selected a melting point value of 130.8 °C for phthalic anhydride ([DOE, 2016](#)) as the representative melting point value closest to the mean of the identified information from the overall high-quality trusted data sources. The identified value replaces the value of 131.4 °C proposed in the *Final Scope of the Risk Evaluation for Phthalic Anhydride (1,3-Isobenzofurandione)*<sup>1</sup>; CASRN 85-44-9 (also called the “final scope document”) ([U.S. EPA, 2020c](#)).

### 2.2.1.2 *o*-Phthalic Acid

A data source providing melting point value for *o*-phthalic acid was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). The EPA has since identified and evaluated 8 high-quality trusted data sources reporting melting points ranging from 191 to 230 °C for *o*-phthalic acid (>99% purity) ([Elsevier, 2020](#); [NCBI, 2020b](#); [Rumble, 2018c](#); [DOE, 2016](#); [Booth et al., 2012](#); [Lorz et al., 2007](#); [Park and Sheehan, 2000](#); [Monroe, 1920](#)). The mean and standard deviation of the reported melting point values within these sources are 206.86 °C and 11.55 °C, respectively. In addition, *o*-phthalic acid has been reported to convert to phthalic anhydride at temperatures near the reported upper bound values of the reported melting point range ([NCBI, 2020b](#)). EPA selected melting point value of 206.75 °C for *o*-phthalic acid ([Booth et al., 2012](#)) as the representative melting point value closest to the mean of the identified information.

## 2.2.2 Boiling Point

The boiling point is one of the inherent properties that informs the chemical’s physical state (*i.e.*, liquid or gas at normal environmental conditions). The boiling point is the temperature at which a chemical substance coexists in equilibrium as vapor and liquid under atmospheric pressure ([Rumble, 2021](#)). Again, the physical state helps inform multiple aspects of the draft risk evaluation as previously described in Section 2.2.1. EPA extracted nine overall high-quality, trusted data sources for phthalic anhydride and one for *o*-phthalic acid. These trusted data sources provided a robust and moderate weight of evidence supporting the boiling point information for both chemicals. These are summarized in Table 2-3 below and discussed in detail in Sections 2.2.2.1 and 2.2.2.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the boiling point values of 284.05 and 324.85 °C for phthalic anhydride and *o*-phthalic acid. Based on the selected boiling point values, both chemical substances (in their pure form) will exist as solids and are not likely to be present as a gas (vapor) under normal environmental conditions.

<sup>1</sup> 1,3-Isobenzofurandione is a primary synonym for phthalic anhydride.

**Table 2-3. Summary of Available Boiling Point Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	9	1
Data points	11	1
Mean	282.37 °C	—
Standard deviation	21.99 °C	—
Minimum	217.85 °C	—
Maximum	295°C	—
Selected value	284.05 °C ( <a href="#">NIST, 2022</a> )	324.85°C ( <a href="#">NCBI, 2020b</a> )
Selection rationale	Reported value closest to the mean of reported values within the available high-quality sources under normal environmental conditions	One available high-quality data source
Confidence level	Robust	Moderate

#### 2.2.2.1 Phthalic Anhydride

The available high-quality, trusted data sources reported boiling points ranging from 217.85 to 295 °C for phthalic anhydride ([NIST, 2022](#); [NCBI, 2020a](#); [U.S. EPA, 2019a](#); [Rumble, 2018b](#); [DOE, 2016](#); [O'Neil, 2013](#); [NIOSH, 2007](#); [OECD, 2005](#); [Park and Sheehan, 2000](#)). The mean and standard deviation of the reported boiling point values within these sources are 282.36 °C and 21.99 °C, respectively. EPA selected a boiling point value of 284.05 °C ([NIST, 2022](#)) for phthalic anhydride as the value that best represents the mean boiling point value within the available high-quality sources under normal environmental conditions. That identified value replaces the previous used value of 285.3 °C proposed in the final scope document ([U.S. EPA, 2020c](#)).

#### 2.2.2.2 *o*-Phthalic Acid

A data source providing boiling point value for *o*-phthalic acid was not identified in the initial data review for the *Final Scope of the Risk Evaluation for Phthalic Anhydride (1,3-Isobenzofurandione)*; CASRN 85-44-9 ([U.S. EPA, 2020c](#)). EPA has since identified one high-quality data source reporting an *o*-phthalic acid boiling point of 324.85 °C ([NCBI, 2020b](#)) and therefore utilized the boiling point value of 324.85 °C ([NCBI, 2020b](#)) under normal environmental conditions.

### 2.2.3 Density

Density is the chemical substance mass per unit volume (*i.e.*, g/mL) ([Rumble, 2021](#)) and is one of the inherent properties that informs assessors about the chemical's mobility in the environment under normal conditions. This information assists the assessors to understand whether the environmental release of phthalic anhydride as *o*-phthalic acid is likely to sink or float in aquatic systems as well as in ambient air. EPA extracted four overall high-quality trusted data sources for phthalic anhydride and four for *o*-phthalic acid. These trusted data sources provided a robust weight of evidence supporting the density information. These are summarized in Table 2-4 and discussed in detail on Sections 2.2.3.1 and 2.2.3.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the density values of 1.527 and 1.593 g/cm<sup>3</sup> for phthalic anhydride and *o*-phthalic acid. Based on the selected values, the available trusted data sources provided a robust weight of evidence that both chemical substances (in their pure form) to be denser than water and air and likely to settle as dust or particles in the atmosphere and quickly dissolve in water under normal environmental conditions.

**Table 2-4. Summary of Available Density Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	4	4
Data points	4	2
Mean	1.439 g/cm <sup>3</sup>	1.584 g/cm <sup>3</sup>
Standard deviation	0.080 g/cm <sup>3</sup>	0.008 g/cm <sup>3</sup>
Minimum	1.20 g/cm <sup>3</sup>	1.576 g/cm <sup>3</sup>
Maximum	1.53 g/cm <sup>3</sup>	1.593 g/cm <sup>3</sup>
Selected value	1.527 g/cm <sup>3</sup> ( <a href="#">NCBI, 2020b</a> )	1.593 g/cm <sup>3</sup> ( <a href="#">Elsevier, 2019</a> )
Selection rationale	Reported value closest to the mean of the reported values within the available high-quality sources under normal environmental conditions	Reported value in 4 of 4 data sources
Confidence Level	Robust	Robust

### 2.2.3.1 Phthalic Anhydride

The available high-quality, trusted data sources reported seven density values ranging from 1.20 to 1.53 g/cm<sup>3</sup> for phthalic anhydride ([Elsevier, 2019](#); [NLM, 2015](#); [O'Neil, 2013](#); [NIOSH, 1978](#)). The mean and standard deviation of the reported density values within these sources are 1.439 and 0.080, respectively. EPA selected a density value of 1.527 g/cm<sup>3</sup> ([NCBI, 2020b](#)) as the value that best represents the mean density value within the available high-quality sources under normal environmental conditions, for phthalic anhydride. The identified value is consistent with the proposed in the final scope document ([U.S. EPA, 2020c](#)).

### 2.2.3.2 *o*-Phthalic Acid

A data source providing a density value for *o*-phthalic acid was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). EPA has since identified and evaluated four high-quality, trusted data sources reporting two density values ranging from 1.576 to 1.593 g/cm<sup>3</sup> for *o*-phthalic acid ([Elsevier, 2020](#); [NCBI, 2020b](#); [RSC, 2020](#); [Lorz et al., 2007](#)). The mean and standard deviation of the reported density values within these sources are 1.584 and 0.008 g/cm<sup>3</sup>, respectively. EPA selected a density value of 1.593 g/cm<sup>3</sup> ([Elsevier, 2019](#)) as the one value reported in all four of the available high-quality sources under normal environmental conditions for *o*-phthalic acid.

## 2.2.4 Vapor Pressure

Vapor pressure indicates the pressure exerted by a liquid or solid chemical in equilibrium with its vapor at a given temperature (25 °C for environmental conditions) (40 CFR 796.1950). This information informs the assessors if a chemical substance has the potential to volatilize and be released into the atmosphere, undergoing long-range transport and being available for specific exposure pathways. This information helps assessors predict concentrations and environmental releases of a chemical substance to air. A chemical's potential to be present in air is expected to increase as vapor pressure increases. EPA extracted six high-quality, trusted data sources for phthalic anhydride and four for *o*-phthalic acid. These trusted data sources provided a robust weight of evidence supporting the vapor pressure information for both chemicals. These are summarized in Table 2-5 and discussed in detail on Sections 2.2.4.1 and 2.2.4.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the vapor pressure values of  $5.14 \times 10^{-4}$  and  $6.4 \times 10^{-7}$  mmHg at 25 °C for phthalic anhydride and *o*-phthalic acid, respectively. Based on the selected physical chemical properties such as the boiling point

(Section 2.2.2) and the selected vapor pressure, both chemical substances (in their pure form) have the potential to be present in the atmosphere—mostly as suspended particles (dust) under normal environmental conditions.

**Table 2-5. Summary of Available Vapor Pressure Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	6	4
Data points	1	2
Mean	—	$6.36 \times 10^{-7}$ mmHg
Standard deviation	—	$2.5 \times 10^{-7}$ mmHg
Minimum	—	$1.38 \times 10^{-7}$ mmHg
Maximum	—	$6.4 \times 10^{-7}$ mmHg
Selected value	$5.17 \times 10^{-4}$ mmHg ( <a href="#">NLM, 2015</a> )	$6.37 \times 10^{-7}$ mmHg ( <a href="#">U.S. EPA, 2020b</a> )
Selection rationale	Reported value in all the available high-quality sources under normal environmental conditions	Reported value in 3 of 4 data sources
Confidence level	Robust	Robust

#### 2.2.4.1 Phthalic Anhydride

The available high-quality, trusted data sources reported six vapor pressure values at temperatures ranging from 20 to 138 °C for phthalic anhydride ([NCBI, 2020a](#); [DOE, 2016](#); [NLM, 2015](#); [NIOSH, 2007](#); [OECD, 2005](#); [Das et al., 1979](#)) but only two reported vapor pressure at 25 °C. Both sources reported the same vapor pressure of  $5.17 \times 10^{-4}$  mmHg at 25 °C ([NCBI, 2020a](#); [NLM, 2015](#)). This vapor pressure was derived from the empirically derived approximation to determine the saturated vapor pressure of solid chemical substances developed by Jones et al. (1960). EPA selected the vapor pressure of  $5.17 \times 10^{-4}$  mmHg at 25 °C ([NLM, 2015](#)) for phthalic anhydride as the value that best represents the one vapor pressure value within the available high-quality sources under normal environmental conditions. This identified value is consistent with that reported in the final scope document ([U.S. EPA, 2020c](#)).

#### 2.2.4.2 *o*-Phthalic Acid

A data source providing a vapor pressure value for *o*-phthalic acid was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). The EPA has since identified and evaluated four high-quality, trusted data sources that reported two vapor pressure values for *o*-phthalic acid. Three of the trusted data sources reported a vapor pressure value of  $6.4 \times 10^{-7}$  mmHg at 25 °C ([NCBI, 2020b](#); [U.S. EPA, 2020b](#); [DOE, 2016](#)), whereas the fourth estimated a subcooled vapor pressure value of  $1.3 \times 10^{-7}$  at 25 °C ([Booth et al., 2012](#)). EPA selected the vapor pressure of  $6.4 \times 10^{-7}$  mmHg at 25 °C ([U.S. EPA, 2020b](#)) for *o*-phthalic acid as the value that best represents the vapor pressure within the available high-quality sources under normal environmental conditions.

#### 2.2.5 Relative Vapor Density

Vapor density is the mass of a vapor per unit volume of the vapor relative to air ([U.S. EPA](#); accessed March 18, 2026). The relative vapor density is the ratio between the vapor density of a chemical substance and the vapor density of air (1.0). Relative vapor densities greater than 1 will indicate a higher tendency to sink and lower than 1 a higher tendency to float in ambient air. This information may inform the predicted fate and transport of chemical substances (as vapors) when released to ambient air. EPA

extracted one overall high-quality data source for phthalic anhydride and one for *o*-phthalic acid. These trusted data sources provided a moderate weight of evidence supporting the vapor density information. They are summarized in Table 2-6 and discussed in Sections 2.2.5.1 and 2.2.5.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the vapor density values of 5.1 and 5.7 for phthalic anhydride and *o*-phthalic acid. Based on the selected values, the available trusted data sources, both chemical substances (in their pure forms) have a high tendency to sink in ambient air under normal environmental conditions.

**Table 2-6. Summary of Available Relative Vapor Density Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	1	1
Data points	2	2
Mean	5.85	5.72
Standard deviation	1.1	0.02
Minimum	5.1	5.7
Maximum	6.6	5.73
Selected value	5.1 ( <a href="#">NCBI, 2020c</a> )	5.7 ( <a href="#">NCBI, 2020b</a> )
Selection rationale	Selected most updated relative vapor density value at 25 °C from the available high-quality data sources	Reported relative vapor density value at 25 °C within available high-quality sources
Confidence level	Moderate	Moderate

#### 2.2.5.1 Phthalic Anhydride

The available high-quality, trusted data sources reported two relative vapor density values of 5.1 and 6.6 for phthalic anhydride ([NCBI, 2020c](#); [NLM, 2015](#)). These values were obtained from the same high-quality data source that reported a vapor density of 6.6 in 2015 but that was replaced with a vapor density of 5.1 in 2020. EPA selected the most updated reported relative vapor density value of 5.1 at 25 °C ([NCBI, 2020c](#)) for this risk evaluation. The identified value is consistent with the final scope document ([U.S. EPA, 2020c](#)).

#### 2.2.5.2 *o*-Phthalic Acid

A data source providing a relative vapor density value for *o*-phthalic acid was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). EPA has since identified and evaluated one high-quality data source that reported two relative vapor density values for *o*-phthalic acid of 5.7 and 5.73 ([NCBI, 2020b](#)). The mean and standard deviation of the reported vapor density values are 5.72 and 0.021, respectively. EPA selected the relative vapor density of 5.7 at 25 °C ([NCBI, 2020b](#)) as the value that best represents the mode vapor density value for *o*-phthalic acid within the available high-quality sources under normal environmental conditions.

#### 2.2.6 Water Solubility

The water solubility indicates the maximum amount of phthalic anhydride or *o*-phthalic acid that will be dissolved in pure water. Water solubility informs many endpoints not only within the realm of fate and transport of phthalic anhydride and *o*-phthalic acid in the environment, but also when modeling for industrial process, and engineering, as well as human and ecological hazard, and exposure assessments. Chemical substances that are soluble in water can be expected to readily disperse through the

environment. EPA extracted eight overall high-quality trusted data sources for phthalic anhydride and seven for *o*-phthalic acid. These sources provided a robust weight of evidence supporting their water solubility information and are summarized in Table 2-7 and discussed in Sections 2.2.6.1 and 2.2.6.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the water solubility values of 6,200 mg/L and 6,994 mg/L at 25 °C for phthalic anhydride and *o*-phthalic acid, respectively. Based on the selected values, the available trusted data sources, both chemical substances (in their pure form) are very soluble in water, expected to partition to surface water and groundwater and, not likely to bioaccumulate under normal environmental conditions.

**Table 2-7. Summary of the Available Water Solubility Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	8	7
Data points	9	11
Mean	6,152.2 mg/L	6,648.4 mg/L
Standard deviation	132.5 mg/L	817.70 mg/L
Minimum	6,000 mg/L	5,330 mg/L
Maximum	6,400 mg/L	7,658 mg/L
Selected value	6,200 mg/L ( <a href="#">U.S. EPA, 2019a</a> )	6,994 mg/L ( <a href="#">U.S. EPA, 2020b</a> )
Selection rationale	Reported value closest to the mean of the values identified information within the available high-quality sources under normal environmental conditions	
Confidence level	Robust	Robust

#### 2.2.6.1 Phthalic Anhydride

A data source providing a water solubility value for phthalic anhydride was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). EPA has since identified and evaluated eight high-quality, trusted data sources reported water solubilities ranging from 6,000 to 6,400 mg/L for phthalic anhydride ([NCBI, 2020a](#); [RSC, 2019](#); [U.S. EPA, 2019a](#); [Rumble, 2018a](#); [O'Neil, 2013](#); [NIOSH, 2007](#); [Park and Sheehan, 2000](#); [NIOSH, 1978](#)). The mean and standard deviation of the reported water solubility values within these sources are 6,152.2 mg/L and 132.5 mg/L, respectively. EPA selected a water solubility value of 6,200 mg/L for phthalic anhydride ([U.S. EPA, 2019a](#)) as the representative water solubility value closest to the mean of the identified information from the overall high-quality trusted data sources.

#### 2.2.6.2 *o*-Phthalic Acid

The available high-quality trusted data sources reported water solubilities ranging from 5,330 to 7,658 mg/L for *o*-phthalic acid ([Elsevier, 2020](#); [NCBI, 2020b](#); [U.S. EPA, 2020b](#); [Rumble, 2018a](#); [Box et al., 2006](#); [Park and Sheehan, 2000](#); [Han et al., 1999](#)). These trusted data sources employed different analytical methods that may have resulted in the wide range of water solubilities. The mean and standard deviation of the reported water solubility values within these sources are 6,648.4 and 817.70 mg/L, respectively. EPA selected a water solubility value of 6,994 mg/L for *o*-phthalic acid ([U.S. EPA, 2020b](#)) as the representative water solubility value closest to the mean of the identified information from the overall high-quality, trusted data sources. The identified value replaces the value of 6,000 mg/L proposed in the final scope document ([U.S. EPA, 2020c](#)).

## 2.2.7 Octanol/Water Partition Coefficient (Log K<sub>ow</sub>)

The octanol-water partition coefficient (log K<sub>ow</sub>) provides information on how the chemical, under equilibrium, will partition between octanol (which represents the lipids or fats in biota) and water (U.S. EPA, 2026; accessed March 18, 2026). The log K<sub>ow</sub> is used as well as for the estimation of other properties including water solubility, bioconcentration, soil adsorption, and aquatic toxicity. EPA extracted four overall high-quality trusted data sources for phthalic anhydride and three for *o*-phthalic acid. These trusted data sources provided a robust weight of evidence supporting the log K<sub>ow</sub> information for phthalic anhydride and *o*-phthalic acid. These are summarized in Table 2-8 and discussed in Sections 2.2.7.1 and 2.2.7.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the log K<sub>ow</sub> values of 1.43 and 0.73 for phthalic anhydride and *o*-phthalic acid, respectively. Based on the selected values, the available trusted data sources, both chemical substances (in their pure form) are expected to be very soluble in water, not likely to partition to suspended organic matter present in the environment, and not likely to bioaccumulate under normal environmental conditions.

**Table 2-8. Summary of Available Log K<sub>ow</sub> Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	4	3
Data points	5	2
Mean	1.39	0.57
Standard deviation	0.38	0.27
Minimum	0.73	0.26
Maximum	1.60	0.73
Selected value	1.43 (Elsevier, 2019)	0.73 (U.S. EPA, 2020b)
Selection rationale	Reported value closest to the mean of the values identified information within the available high-quality sources under normal environmental conditions	
Confidence level	Robust	Robust

### 2.2.7.1 Phthalic Anhydride

A data source providing a log K<sub>ow</sub> value for phthalic anhydride was not identified in the initial data review for the final scope document (U.S. EPA, 2020c). EPA has since identified and evaluated four high-quality, trusted data sources reported log K<sub>ow</sub> values ranging from 0.73 to 1.6 for phthalic anhydride (Elsevier, 2019; U.S. EPA, 2019a; NLM, 2015; OECD, 2005). The mean and standard deviation of the reported log K<sub>ow</sub> values within these sources are 1.392 and 0.377. EPA selected a log K<sub>ow</sub> value of 1.43 for phthalic anhydride (Elsevier, 2019) as the representative value closest to the mean of the identified information from the overall high-quality, trusted data sources.

### 2.2.7.2 *o*-Phthalic Acid

The available high-quality trusted data sources reported log K<sub>ow</sub> values ranging from 0.26 to 0.73 for *o*-phthalic acid (Elsevier, 2020; NCBI, 2020b; U.S. EPA, 2020b). The mean and standard deviation of the reported log K<sub>ow</sub> values within these sources are 0.573 and 0.271, respectively. EPA selected a log K<sub>ow</sub> value of 0.73 for *o*-phthalic acid (U.S. EPA, 2020b) as the representative value closest to the mean of the identified information from the overall high-quality, trusted data sources. The identified value replaces the log K<sub>ow</sub> value of 1.6 proposed in the final scope document (U.S. EPA, 2020c).

### 2.2.8 Octanol/Air Partition Coefficient (Log K<sub>OA</sub>)

The octanol-air partition coefficient (log K<sub>OA</sub>) provides information on how the chemical, under equilibrium, will partition between octanol and air (U.S. EPA, 2025; accessed March 25, 2026). This informs how the chemical is likely to partition in the environment between air and aerosol particles, air and foliage, and air and soil. This information also helps to understand how chemical substances are expected to behave in the atmosphere as well as in human respiratory tissues. Chemical substances with high log K<sub>OA</sub> are more likely to sorb onto solid surfaces as well as to bioaccumulate in the human respiratory tissue. A data source providing a log K<sub>OA</sub> for phthalic anhydride and *o*-phthalic acid was not identified in the initial data review for the final scope document (U.S. EPA, 2020c). The predicted log K<sub>OA</sub> of phthalic anhydride and *o*-phthalic acid are 5.656 and 11.120, respectively (U.S. EPA, 2017). EPA selected these values as the representative log K<sub>OA</sub> values for phthalic anhydride and *o*-phthalic acid obtained from EPI Suite™ (U.S. EPA, 2017). The predicted values provided a moderate weight of evidence that both chemical substances (in their pure form) are not expected to partition to air from organic surfaces. Furthermore, the reported vapor pressure, boiling point, Henry's Law constant (see more below), and results of the fugacity model also indicate that both chemicals are not expected to partition to air.

### 2.2.9 Henry's Law Constant

The Henry's Law constant (HLC) of a chemical substance is the ratio of the substance's vapor pressure and water solubility (U.S. EPA, 2026; accessed March 18, 2026). The HLC (atm×m<sup>3</sup>/mol) provides an indication of a chemical's volatility from water and gives an indication of potential environmental partitioning, potential removal in sewage treatment plants during air stripping, and possible routes of environmental exposure. EPA extracted two medium confidence, trusted data sources for phthalic anhydride and one for *o*-phthalic acid containing a moderate weight of evidence supporting the log HLC (atm×m<sup>3</sup>/mol) information. These are summarized in Table 2-9 and discussed in detail in Sections 2.2.9.1 and 2.2.9.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the log HLC [atm×m<sup>3</sup>/mol] values of -7.77 and less than -10 for phthalic anhydride and *o*-phthalic acid, respectively. Based on the selected values and the available trusted data sources, both chemicals (in their pure form) are not expected to volatilize from water under normal environmental conditions. Based on the reported water solubility and vapor pressure values, there is a robust level of confidence that phthalic anhydride and *o*-phthalic acid are not expected to volatilize from water under normal environmental conditions.

**Table 2-9. Summary of Available Log (HLC [atm×m<sup>3</sup>/mol]) Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from Medium-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	2	1
Data points	1	1
Mean	—	—
Standard deviation	—	—
Minimum	—	—
Maximum	—	—
Selected value	-7.77 (NCBI, 2020a)	Less than -10 (U.S. EPA, 2012)
Selection rationale	EPISuite™ estimate selected, limited available information	
Confidence level	Moderate	Moderate

### 2.2.9.1 Phthalic Anhydride

A data source providing a log HLC ( $\text{atm} \times \text{m}^3/\text{mol}$ ) value for phthalic anhydride was not identified in the initial data review for the final scope document (U.S. EPA, 2020c). EPA has since identified and evaluated two medium-quality trusted data sources reported a single log HLC ( $\text{atm} \times \text{m}^3/\text{mol}$ ) value of  $-7.77$  for phthalic anhydride (NCBI, 2020a; Health Canada, 2019). The Agency selected the single log HLC value of  $-7.77$  for phthalic anhydride (NCBI, 2020a) as the representative log HLC within the identified information from the overall medium-quality, trusted data sources.

### 2.2.9.2 o-Phthalic Acid

The one available high-quality data source reported log HLC ( $\text{atm} \times \text{m}^3/\text{mol}$ ) value of lower than  $-10$  for *o*-phthalic acid (U.S. EPA, 2012) was selected for this TSD and the draft risk evaluation. The identified value is consistent with the value proposed in the final scope document (U.S. EPA, 2020c).

## 2.2.10 Flash Point

The flash point is the lowest temperature at which a substance produces sufficient vapor to form an ignitable mixture with air (U.S. EPA, 2026; accessed March 18, 2026). This helps fate assessors understand the fire hazards of the chemical. EPA extracted four overall high-quality, trusted data sources for phthalic anhydride and three for *o*-phthalic acid. These trusted data sources provided a robust weight of evidence supporting the flash point for both phthalic anhydride and *o*-phthalic acid. These are summarized in Table 2-10 and discussed in Sections 2.2.10.1 and 2.2.10.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the flash point values of  $152^\circ\text{C}$  and  $168^\circ\text{C}$  for phthalic anhydride and *o*-phthalic acid under normal environmental conditions. Based on the selected values, the available trusted data sources, phthalic anhydride and *o*-phthalic acid (in their pure form) are not expected to form ignitable mixtures at normal environmental conditions.

**Table 2-10. Summary of Available Flash Point Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	4	3
Data points	4	1
Mean	$154^\circ\text{C}$	—
Standard deviation	$6^\circ\text{C}$	—
Minimum	$151^\circ\text{C}$	—
Maximum	$165^\circ\text{C}$	—
Selected value	$152^\circ\text{C}$ (Rumble, 2018b)	$168^\circ\text{C}$ (Rumble, 2018b)
Selection rationale	Reported value closest to the mean of values identified information within the available high-quality sources under normal environmental conditions	Single value reported by three available high-quality data sources
Confidence level	Robust	Moderate

### 2.2.10.1 Phthalic Anhydride

The available high-quality trusted data sources reported flash point values ranging from  $151$  to  $165^\circ\text{C}$  for phthalic anhydride (Rumble, 2018b; NIOSH, 2007; Park and Sheehan, 2000; NIOSH, 1978). The mean and standard deviation of the reported flash point values within these sources are  $154$  and  $6^\circ\text{C}$ , respectively. EPA selected a flash point value of  $152^\circ\text{C}$  for phthalic anhydride (Rumble, 2018b) as the representative flash point value closest to the mean of the identified information from the overall high-

quality ,trusted data sources. The identified value is consistent with the value proposed in the final scope document ([U.S. EPA, 2020c](#)).

#### 2.2.10.2 *o*-Phthalic Acid

A data source providing a flash point value for *o*-phthalic acid was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). EPA has since identified and evaluated three available high-quality, trusted data sources reported a single flash point value of 168 °C for *o*-phthalic acid ([Rumble, 2018b](#)), which was selected for this draft TSD.

#### 2.2.11 Autoflammability

Autoflammability is the lowest temperature a chemical substance will spontaneously ignite without a spark or flame ([Rumble, 2021](#)). Like the flash point, this helps fate assessors understand the fire hazards of the chemical. EPA extracted three overall high-quality, trusted data sources containing a robust weight of evidence supporting the flash point for phthalic anhydride. No autoflammability information was found within the available trusted data sources for *o*-phthalic acid. These are summarized in Table 2-11 and discussed in detail on Sections 2.2.11.1 and 2.2.11.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the autoflammability value of 584 °C for phthalic anhydride under normal environmental conditions. Based on the selected value from the available trusted data sources, phthalic anhydride (in pure form) is not expected to spontaneously ignite without a spark or flame at normal environmental conditions. *o*-Phthalic acid is not expected to readily auto-ignite under most environmental conditions.

**Table 2-11. Summary of Available Autoflammability Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	3	—
Data points	3	—
Mean	578 °C	—
Standard deviation	7 °C	—
Minimum	570 °C	—
Maximum	584 °C	—
Selected value	584°C ( <a href="#">Park and Sheehan, 2000</a> )	—
Selection rationale	Reported value closest to the mean of values identified information within the available high-quality sources under normal environmental conditions	—
Confidence level	Robust	—

##### 2.2.11.1 Phthalic Anhydride

A data source providing an autoflammability value for phthalic anhydride was not identified in the initial data review for the final scope document ([U.S. EPA, 2020c](#)). The EPA has since identified and evaluated 3 high-quality trusted data sources reported autoflammability values ranging from 570 °C to 584 °C for phthalic anhydride ([Rumble, 2018b](#); [OECD, 2005](#); [Park and Sheehan, 2000](#)). The mean and standard deviation of the reported autoflammability values within these sources are 578 °C and 7 °C, respectively. EPA selected an autoflammability value of 584 °C for phthalic anhydride ([Park and Sheehan, 2000](#)) as the representative flash point value closest to the mean of the identified information from the overall high-quality, trusted data sources.

### 2.2.11.2 *o*-Phthalic Acid

No autoflammability information was uncovered within the available trusted data sources for *o*-phthalic acid. However, *o*-phthalic acid's flash point temperature and boiling point temperature are higher than those reported for phthalic anhydride. Therefore, *o*-phthalic acid flash point is expected to be higher than 584 °C and is not expected to readily auto-ignite under most environmental conditions.

### 2.2.12 Viscosity

Viscosity is the expected flow resistance of a chemical substance due to molecular friction within a fluid (U.S. EPA, 2026; accessed March 18, 2026). This helps fate assessors understand the transport of a chemical substance directly released to the environment. EPA extracted three overall high-quality, trusted data sources containing a robust weight of evidence supporting the viscosity for phthalic anhydride. No viscosity information was uncovered within the available trusted data sources for *o*-phthalic acid. These are summarized in Table 2-12 and discussed in detail on Sections 2.2.12.1 and 2.2.12.2 for phthalic anhydride and *o*-phthalic acid, respectively. In summary, EPA selected the viscosity value of 1.125 cP (centipoise) for phthalic anhydride and no viscosity information was uncovered within the available trusted data sources for *o*-phthalic acid under normal environmental conditions. However, the water solubility of phthalic anhydride and *o*-phthalic acid indicates these substances to rapidly partition to aquatic environments and have negligible flow resistance under most environmental conditions.

**Table 2-12. Summary of Available Viscosity Information for Phthalic Anhydride and *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	Phthalic Anhydride	<i>o</i> -Phthalic Acid
Data sources	3	—
Data points	3	—
Mean	1.147 cp (centipoise)	—
Standard deviation	0.038 cp	—
Minimum	1.125 cp	—
Maximum	1.190 cp	—
Selected value	1.125 cp (NCBI, 2020a)	—
Selection rationale	Reported value closest to mean of values identified information within the available high-quality sources under normal environmental conditions	—
Confidence level	Robust	—

#### 2.2.12.1 Phthalic Anhydride

The available high-quality trusted data sources reported viscosity values ranging from 1.125 to 1.190 cp for phthalic anhydride (NCBI, 2020a; NLM, 2015; OECD, 2005). The mean and standard deviation of the reported viscosity values within these sources are 1.147 and 0.038 cp, respectively. EPA selected a viscosity value of 1.125 cp for phthalic anhydride (NCBI, 2020a) as the representative viscosity value closest to the mean of the identified information from the overall high-quality, trusted data sources. The identified replaces the value of 1.19 cp proposed in the final scope document (U.S. EPA, 2020c).

#### 2.2.12.2 *o*-Phthalic Acid

No viscosity information was uncovered within the available trusted data sources for *o*-phthalic acid. However, the water solubility of *o*-phthalic acid, 6,994 mg/L, (U.S. EPA, 2020b) suggests high

partitioning to aquatic environments and negligible flow resistance under most environmental conditions.

### 2.2.13 Dissociation Constants (pKa<sub>1</sub> and pKa<sub>2</sub>) of *o*-Phthalic Acid

Phthalic anhydride is expected to rapidly hydrolyze to *o*-phthalic acid. *o*-Phthalic acid (a weak organic acid) is expected to rapidly dissociate in water under normal environmental conditions, as described by the corresponding acid dissociation constant. The acid dissociation constant describes a chemical substance's potential to lose its hydrogen ions in water (as a function of pH) and this is commonly reported as the negative base-10 logarithm of the acid dissociation constant (pKa). The pKa values, which are unitless, help fate assessors to predict the dominant form of a chemical substance in the environment, its fate and transport, and bioavailability. A data source providing pKa values for *o*-phthalic acid was not identified in the initial data review for the final scope document (U.S. EPA, 2020c). The EPA has since identified and extracted nine overall high-quality trusted data sources containing a robust weight of evidence supporting the pKa values for *o*-phthalic acid (Table 2-13).

The available high-quality trusted data sources reported values ranging from 2.36 to 3.11 and 4.61 to 5.55 for *o*-phthalic acid first (pKa<sub>1</sub>) and second (pKa<sub>2</sub>) dissociation constants, respectively (Elsevier, 2020; NCBI, 2020b; Rumble et al., 2018; Tummanapelli and Vasudevan, 2015; Box et al., 2006; Partanen and Covington, 2006b; Park and Sheehan, 2000; Tam and Takacs-Novak, 1999; Hamer et al., 1945). The mean value and standard deviation of the reported pKa<sub>1</sub> values within these sources are 2.850 and 0.2023. The mean value and standard deviation of the reported pKa<sub>2</sub> values within these sources are 5.392 and 0.1776. EPA selected the values of 2.91 (Tummanapelli and Vasudevan, 2015) and 5.399 (Partanen and Covington, 2006a) as the representative pKa<sub>1</sub> and pKa<sub>2</sub> values closest to the mean of the identified information from the overall high-quality, trusted data sources for *o*-phthalic acid. In general, the available trusted data sources, *o*-phthalic acid will rapidly dissociate in water and will exist predominantly as an anion in the environment (Figure 1-1).

**Table 2-13. Summary of Available Acid Dissociation Constant Information for *o*-Phthalic Acid Obtained from High-Quality, Trusted Data Sources**

Data Details	First Acid Dissociation Constant (pKa <sub>1</sub> )	Second Acid Dissociation Constant (pKa <sub>2</sub> )
Data sources	9	8
Data points	11	59
Mean	2.850 (unitless)	5.392 (unitless)
Standard deviation	0.202 (unitless)	0.178 (unitless)
Minimum	2.360 (unitless)	4.610 (unitless)
Maximum	3.110 (unitless)	5.550 (unitless)
Selected value	2.91 (unitless) (Tummanapelli and Vasudevan, 2015)	5.399 (unitless) (Partanen and Covington, 2006a)
Selection rationale	Reported value is closest to mean of the values identified information within available high-quality sources under normal environmental conditions	
Confidence level	Robust	Robust

## 2.3 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Physical and Chemical Property Assessment

The representative physical and chemical property values were selected based on professional judgement and the overall data quality ranking of the associated references. These physical and chemical

property values are then used for making chemical specific decisions across other disciplines. Identification and selection of high-quality data are crucial for physical and chemical properties; however, in case of few or no high-quality studies are identified, a mix of high-to-medium studies or medium studies may be considered for selection. In some instances where no data were available, or there was a wide range of data that generally, but did not consistently agree with one another, models such as EPI Suite™ were used to estimate the endpoint value for the chemical substance (*i.e.* octanol-air partitioning coefficient and HLC) and cross-checked with reported data from systematic review. The number and overall quality of the available trusted data sources results in different confidence strength levels for the corresponding selected physical and chemical property values as described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* ([U.S. EPA, 2021](#)).

In general, the available trusted data sources provided a robust weight of evidence that phthalic anhydride released to the environment will rapidly hydrolyze to *o*-phthalic acid. Under normal environmental conditions *o*-phthalic acid is

- a water soluble solid that maybe present in the atmosphere as suspended particles/dust;
- likely to partition to surface and ground water;
- not likely to volatilize from water and dry surfaces;
- not likely to bioaccumulate;
- predominantly present as an anion in aquatic environments; and
- likely to rapidly biodegrade.

### 3 APPROACH AND METHODOLOGY FOR FATE AND TRANSPORT ASSESSMENT

Under normal environmental conditions, phthalic anhydride is expected to hydrolyze into *o*-phthalic acid in the presence of water order within minutes (NCBI, 2020c) as shown in Figure 1-1. Therefore, for the purpose of this draft fate assessment, EPA focused on the environmental fate and transport of phthalic anhydride as *o*-phthalic acid as it is the main transformation product of phthalic anhydride released into the environment. In assessing the environmental fate and transport of *o*-phthalic acid, EPA considered reasonably available environmental fate data including biotic and abiotic biodegradation rates, removal of *o*-phthalic acid during wastewater treatment, volatilization from lakes and rivers, and its organic carbon:water partition coefficient (log K<sub>OC</sub>). The full range of results from trusted data sources that were rated high- and medium-quality were evaluated. Medium-quality trusted data sources were considered for fate endpoints when no high-quality trusted data sources were available for the chemical.

Information on the full extracted dataset is available in the file *Draft Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for Phthalic Anhydride* (U.S. EPA, 2026b). When no measured data were available from high- or medium-quality trusted data sources, fate values were derived from EPI Suite™ (U.S. EPA, 2017), a predictive tool for physical and chemical properties and environmental fate estimation. Information regarding the model inputs is available in Section 3.2.1.

Table 3-1 provides a summary of the selected data that EPA considered while assessing the environmental fate of phthalic anhydride and was updated after publication of final scope document (U.S. EPA, 2020c) with additional information identified through the systematic review process.

**Table 3-1. Summary of Environmental Fate Values for *o*-Phthalic Acid**

Parameter	Selected Value(s)	Reference(s)	Data Quality Rating
Octanol:water partition coefficient (log K <sub>OW</sub> )	0.73	<a href="#">U.S. EPA (2020b)</a>	High
Organic carbon:water partition coefficient (log K <sub>OC</sub> ) (L/kg)	1.07 (average of experimental K <sub>OC</sub> values) 0.89 (average of predicted K <sub>OC</sub> values)	<a href="#">NCBI (2020b);</a> <a href="#">U.S. EPA (2020b)</a>	Medium
Adsorption coefficient (log K <sub>d</sub> ) (L/kg)	2.65–3.10 (suspended particulate matter/water)	<a href="#">Dagnelie et al. (2014)</a>	High
Octanol:air partition coefficient (log K <sub>OA</sub> )	11.120 (EPI Suite estimate)	<a href="#">U.S. EPA (2017)</a>	High
Air:water partition coefficient (log K <sub>AW</sub> )	–9.087 (air/water part.coef.) (estimated)	<a href="#">U.S. EPA (2017)</a>	High
Aerobic primary biodegradation in water – removal	100% in 14 days t <sub>1/2</sub> < 3 days at pH = 7.2	<a href="#">Fujita et al. (2005)</a>	High
Aerobic ultimate biodegradation water	40-50% loss and t <sub>1/2</sub> = 9–18 days (activated sludge)	<a href="#">Fujita et al. (2005)</a>	High

Parameter	Selected Value(s)	Reference(s)	Data Quality Rating
Anaerobic biodegradation in water	85% to complete mineralization after 8 weeks	<a href="#">Shelton and Tiedje (1984)</a>	High
Aerobic biodegradation in soil	Complete biodegradation at initial concentrations <100 mg/L under aerobic conditions. $t_{1/2}$ = 0.6 days (25 mg/L) $t_{1/2}$ = 7 days (500 mg/L)	<a href="#">Zhao et al. (2016)</a>	High
Anaerobic biodegradation in landfill – removal	50 mg/L <i>o</i> -phthalic acid completely mineralized under simulated anaerobic landfill conditions after 100 days and pH of 7	<a href="#">Ejlertsson et al. (1996)</a>	High
Anaerobic biodegradation in sediment – removal	82.7% degradation of 20 mg/L <i>o</i> -phthalic acid after 44 days on water and sediment slurry solutions under anaerobic conditions at room temperature	<a href="#">Liu et al. (2005)</a>	High
Photolysis	Direct: Expected to be susceptible to direct photolysis by sunlight; contains chromophores that absorb at wavelengths >290 nm	<a href="#">NCBI (2020b)</a>	High
	Indirect: $t_{1/2}$ = 8.65 days (estimated; based on a 12-hour day with $1.5E06 \cdot OH/cm^3$ and $\cdot OH$ rate constant of $1.237E-12 cm^3/molecule-sec$ )	<a href="#">U.S. EPA (2017)</a>	High
Environmental degradation half-lives (selected values for modeling)	8.65 days (air) 3 days (water) 6 days (soil) 27 days (sediment)	<a href="#">U.S. EPA (2017)</a>	High
Wastewater treatment plant (WWTP) removal	2% (predicted sorption)  10–20% (estimated based on hydraulic detention time of 1.4 days and aerobic biodegradation)	<a href="#">U.S. EPA (2017)</a>	High
Aquatic bioconcentration (BCF)	3.2 L/kg, calculated from the octanol-water partition coefficients ( $\log K_{ow} = 0.73$ )	<a href="#">OECD (2005)</a>	High
Aquatic bioaccumulation factor (BAF)	1.32 L/kg ww (upper trophic Arnot-Gobas estimation)	<a href="#">U.S. EPA (2020b)</a>	High

### 3.1 Tier I Analysis

To help both understand and predict the behaviors and effects of phthalic anhydride as *o*-phthalic acid in

the environment, a tier I analysis determines whether an environmental compartment (e.g., air, water, etc.) will accumulate *o*-phthalic acid at concentrations that may lead to unreasonable risk (i.e., major compartment) or are unlikely to result in risk (i.e., minor compartment). The first step in identifying the major and minor compartments for *o*-phthalic acid is to consider partitioning values (Table 3-1), which indicate the potential for a substance to favor one compartment over another.

### 3.1.1 Soil, Sediment, and Biosolids

Based on the partitioning values shown in Table 3-1, phthalic anhydride as *o*-phthalic acid is expected to have negligible sorption to soil, sediment, and rapidly migrate to groundwater and surface water. Therefore, soil, sediment, and biosolids are considered minor compartments for *o*-phthalic acid. *o*-Phthalic acid is expected to have a biodegradation half-life of days to weeks (Section 4.1) in soils and biosolids, and half-life of weeks in sediments (Section 4.1).

### 3.1.2 Air

*o*-Phthalic acid is a solid at environmental temperatures with a melting point of 206.75 °C (Booth et al., 2012) and a low vapor pressure of  $6.36 \times 10^{-7}$  mm Hg at 25 °C (U.S. EPA, 2020b). This suggests low airborne concentrations of *o*-phthalic acid in the atmosphere and a predominant presence in air as suspended particles (dust). The predicted logarithmic octanol:air coefficient (log  $K_{OA}$ ) of 11.120 (U.S. EPA, 2017) indicates that *o*-phthalic acid is expected to have a higher tendency to accumulate within the organic carbon present in airborne particles than air (as a vapor). Based on *o*-phthalic acid's water solubility of 6,994 mg/L (U.S. EPA, 2020b) and predicted atmospheric half-life of 8.65 days (U.S. EPA, 2017), abiotic processes such as atmospheric (wet and dry) deposition and indirect photolysis are expected to reduce *o*-phthalic acid persistence in air. For instance, *o*-phthalic acid has been detected in both snow and rain samples collected near the University of Massachusetts (Dartmouth campus) during the winters of 2003 to 2010 at concentrations of 7.22 to 76.5 nM (Zuo et al., 2011). However, because *o*-phthalic acid has been reported to be naturally produced within the environment (Huang et al., 2021) and also associated with the presence of phthalate esters, it is difficult to determine whether the source of *o*-phthalic acid in the environment is due to phthalic anhydride.

### 3.1.3 Water

The experimental water solubility of 6,994 mg/L (U.S. EPA, 2020b), predicted logarithmic air:water partitioning coefficient (log  $K_{AW}$ ) value of -9.087 and HLC lower than  $1 \times 10^{-10}$  atm·m<sup>3</sup>/mol (U.S. EPA, 2017), indicates that *o*-phthalic acid released to water is not expected to partition to ambient air from water. The predicted logarithmic organic carbon:water partitioning coefficient (log  $K_{OC}$  [L/kg]) of 1.07 (NCBI, 2020b) suggests negligible sorption to soil, sediment, and rapid migration to groundwater and surface water. *o*-Phthalic acid present in soil, sediments, and landfills is expected to rapidly migrate to groundwater and surface water. Because drinking and wastewater treatment based on sorption process are not expected to efficiently remove *o*-phthalic acid from water, surface water and groundwater are considered major compartments for phthalic acid. However, *o*-phthalic acid present in water is expected to have a biodegradation half-life of days.

## 3.2 Tier II Analysis

A Tier II analysis involves reviewing environmental release information for phthalic anhydride to determine whether further assessment is warranted for each environmental medium. EPA evaluated the exposure data reported to EPA's Toxics Release Inventory (TRI) program. The TRI database contains information on chemical waste management activities that are reported to EPA by industrial and federal facilities. Under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) phthalic anhydride, but not *o*-phthalic acid, has been a TRI-reportable substance since January 1, 1987 (40 CFR 372.65).

In 2018, the TRI program reported production-related waste management data for phthalic anhydride by 121 facilities (U.S. EPA, 2019b). These facilities reported a total of 12,592,162 lb of production-related waste managed. Of this total, 73.1% were treated (9,204,870 lb), 18.4% were recycled (2,316,958 lb), 6.4% were burned for energy recovery (805,898 lb), and 2.1% were released to the environment (264,435 lb). Of the 2.1% of the production-related phthalic anhydride that is managed and released to the environment, environmental releases included 76.6% to air (202,558 lb), 13.5% to land (35,699 lb), and 9.4% for off-site and publicly owned treatment works (POTW for wastewater; 24,857 lb). After undergoing wastewater treatment processes, the disposal of wastewater or liquid wastes results in effluent discharge to water and land application of biosolids, which would lead to media-specific evaluations (Table 3-2). Releases from landfills and incinerators will occur from the disposal of liquid and solid wastes and warrants media specific evaluations. Once in the environment, phthalic anhydride is expected to be transformed into *o*-phthalic acid and rapidly migrate to surface and groundwater as previously described in Section 3.1.

**Table 3-2. Summary of Key Environmental Pathways and Media-Specific Evaluations**

Environmental Releases	Key Pathway	Media-Specific Evaluations
Wastewater and liquid waste treatment	Effluent discharge to water and land application of biosolids	Water, sediment, soil, groundwater, and biosolids
Disposal of liquids and solids to landfills	Leachate discharge to water and biogas to air	Water, sediment, soil, and groundwater
Industrial releases to air	Stack emissions to air	Air, water, sediment, soil, and groundwater
Incineration of liquid and solids	Stack emissions to air and ash to landfill	Air, water, sediment, soil, and groundwater
Urban/remote areas	Deposition	Water and soil
	Partitioning	Water, sediment, soil, and groundwater

### 3.2.1 Fugacity Modeling

The approach described by Mackay (1996) using the Level III Fugacity model in EPI Suite™ (V4.11) (LEV3EPI™) was used for this Tier II analysis. LEV3EPI is described as a steady-state, non-equilibrium model that uses a chemical's physical and chemical properties and degradation rates to predict partitioning of the chemical between environmental compartments and its persistence in a model environment (U.S. EPA, 2017).

The following input parameters were used for the Level III Fugacity model in EPI Suite™:

- Melting point = 206.75 °C
- Vapor pressure =  $6.36 \times 10^{-7}$  mm Hg
- Water solubility = 6,994 mg/L
- Log K<sub>ow</sub> = 0.73
- SMILES: O=C(O)c(c(cc1)C(=O)O)c1

Physical and chemical properties of *o*-phthalic acid were taken directly from Section 2.1. Environmental degradation half-lives were taken from high-quality studies that were identified through systematic review to use information from the best available source and help reduce the levels of uncertainties. The

environmental degradation half-life of *o*-phthalic acid in water of 3 days was selected to represent the range of identified primary biodegradation half-life values (Section 4.1) from high-quality studies to reduce levels of uncertainties. An experimental degradation rate in air was not available and EPA used environmental degradation half-lives of 8.65 days in air (based on AEROWIN Model-predicted values, an atmospheric fate prediction model within EPI Suite<sup>TM</sup>), 6 days in soil (double the half-life in water), and 27 days in sediment (9 times the half-life in water) as recommended for EPIWIN estimations (U.S. EPA, 2017). The Level III Fugacity Model estimated *o*-phthalic acid's overall environmental half-life of 8 days (100% *o*-phthalic acid released to air); 4 days (100% *o*-phthalic acid released to water); 8 days (100% *o*-phthalic acid released to soil); and 7 days (equal release of *o*-phthalic acid to air, water, and soil). For the draft risk evaluation, EPA selected an overall environmental half-life of 4 to 8 days for *o*-phthalic acid.

Based on *o*-phthalic acid's environmental half-lives, partitioning characteristics, and the results of Level III Fugacity modeling, *o*-phthalic acid is expected to be found predominantly in water and soil (Figure 3-1). *o*-Phthalic acid is expected to partition primarily to soil from releases to air or in scenarios of direct soil release. However, based on the water solubility, *o*-phthalic acid releases to soil are expected to partition to water. Once in water, *o*-phthalic acid is expected to remain primarily in water. Further discussion of *o*-phthalic acid partitioning and a media-specific assessment can be found in Section 5.

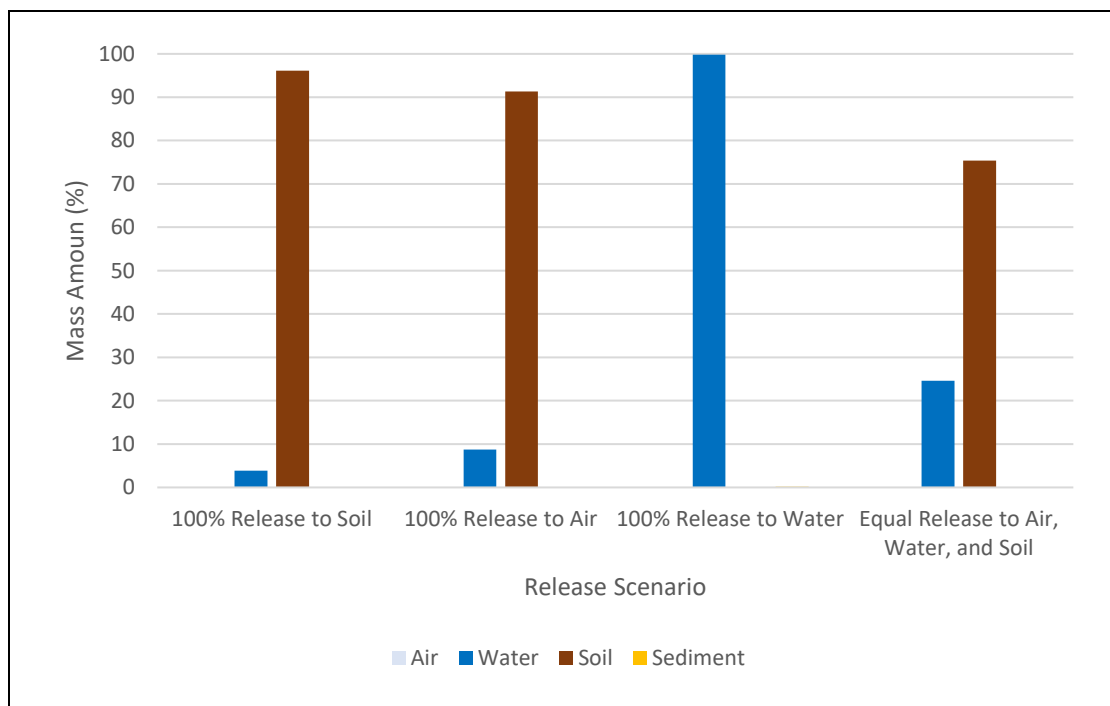


Figure 3-1. EPI Suite<sup>TM</sup> Level III Fugacity Modeling Graphical Result for *o*-Phthalic Acid

## 4 TRANSFORMATION PROCESSES

Phthalic anhydride as *o*-phthalic acid released to the environment is expected to readily degrade via abiotic processes such as photolysis (direct and indirect) and biodegradation in the order of days to weeks. EPA considered *o*-phthalic acid transformation products qualitatively but, due to their lack of persistence, the Agency does not expect those products to substantially contribute to risk; therefore, EPA is not considering them further in this draft risk evaluation. Both biotic and abiotic routes of degradation for *o*-phthalic acid are described in the sections below.

### 4.1 Biodegradation

*o*-Phthalic acid can be considered readily biodegradable in most aquatic environments with extended half-lives in soils and anaerobic environmental compartments. EPA extracted and evaluated 16 trusted data sources containing a robust weight of evidence supporting *o*-phthalic acid biodegradation in water, landfill, soils and sediments under aerobic and anaerobic conditions (Table 4-1). Fifteen of these trusted data sources were classified as overall high-quality source and one as overall medium-quality source. The available trusted data sources contained a robust weight of evidence suggesting *o*-phthalic acid is readily biodegradable in the environment and wastewater treatment processes, persists for extended periods of time under anaerobic conditions, and has an environmental biodegradation half-life on the order of days to weeks as presented below.

Expected biodegradation half-lives:

- water – expected biodegradation half-life of days;
- soils and landfills – expected biodegradation half-life of days to weeks; and
- sediments – expected biodegradation half-life of weeks

**Table 4-1. Summary of *o*-Phthalic Acid Biodegradation Information**

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Aerobic primary biodegradation in water – removal	100% in 14 days $t_{1/2} < 3$ days at pH = 7.2	<a href="#">Fujita et al. (2005)</a>	High
	>99% in 1 day Semicontinuous activated sludge biofilm reactor	<a href="#">Saeger and Tucker (1976)</a>	High
	100% in 2 hours (0.3 mM) 86% in 2 hours (0.6 mM) pH 7.0 to 8.0	<a href="#">Tang et al. (2017)</a>	High
Aerobic ultimate biodegradation water	64% in 5 days with complete loss in 20 days at pH = 2.6	<a href="#">Cannon Laboratories (1977)</a>	High
	40–50% loss and $t_{1/2} = 9$ –18 days (activated sludge)	<a href="#">Fujita et al. (2005)</a>	High
	20–35% loss and $t_{1/2} = 11$ –18 days (river water) 20–35% loss and $t_{1/2} = 21$ –37 days (pond water)		

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Anaerobic ultimate biodegradation in water	Complete mineralization of 50 mg/L <i>o</i> -phthalic acid after 4 weeks	<a href="#">Battersby and Wilson (1989)</a>	High
	Mineralization $t_{1/2} = 7$ days seeded with sludge from a CSTR <sup>a</sup> with 50 mg <sub>COD</sub> /L <i>o</i> -phthalic acid	<a href="#">Kleerebezem et al. (1999)</a>	High
	78 ± 36 % mineralization of 50 mM <i>o</i> -phthalic acid after 21 weeks	<a href="#">Levén and Schnürer (2005)</a>	Medium
	85 % to complete mineralization after 8 weeks	<a href="#">Shelton and Tiedje (1984)</a>	High
	60 % to complete mineralization incubated on 10% fresh sludge from 9 municipalities from mid-Michigan (8 weeks).		
Aerobic biodegradation in soil	19.2–21.1% loss after 30 days; soil pH = 5.0	<a href="#">Evans (1998)</a>	High
	32% primary biodegradation 19% mineralization in 50 hours, pH = 8.2	<a href="#">Ortiz et al. (2003)</a>	High
	47 % mineralization and initial half-life of 2 days in sludge amended soil achieved after 3 days at pH of 5.9 and 20 °C.	<a href="#">Roslev et al. (1998)</a>	High
	Complete biodegradation at initial concentrations lower than 100 mg/L under aerobic conditions. $t_{1/2} = 0.6$ days (25 mg/L) $t_{1/2} = 7$ days (500 mg/L)	<a href="#">Zhao et al. (2016)</a>	High
Anaerobic biodegradation in landfill – removal	50 mg/L <i>o</i> -phthalic acid completely mineralized under simulated anaerobic landfill conditions after 100 days and pH of 7	<a href="#">Ejlertsson et al. (1996)</a>	High
Anaerobic biodegradation in sediment-Removal	82.7% degradation of 20 mg/L <i>o</i> -phthalic acid after 44 days on water and sediment slurry solutions under anaerobic conditions at room temperature	<a href="#">Liu et al. (2005)</a>	High
	99% to complete mineralization under anaerobic conditions at pH of 7 after 8 weeks	<a href="#">MSU (1981)</a>	High
	Complete degradation of <i>o</i> -phthalic acid (20–30 mg/L) after 180 to 198 days in a CO <sub>2</sub> and CO <sub>2</sub> /H <sub>2</sub>	<a href="#">Liu and Chi (2003)</a>	High

Property	Selected Value(s)	Reference(s)	Data Quality Rating
	atmosphere with pH of 7.04–8.11		
<sup>a</sup> CSTR = continuously stirred tank reactor			

#### 4.1.1 Biodegradation in Water

The EPA reviewed and evaluated seven high-quality, trusted data sources ([Tang et al., 2017](#); [Fujita et al., 2005](#); [Kleerebezem et al., 1999](#); [Battersby and Wilson, 1989](#); [Shelton and Tiedje, 1984](#); [Cannon Laboratories, 1977](#); [Saeger and Tucker, 1976](#)) and one medium-quality data source ([Levén and Schnürer, 2005](#)) containing a robust weight of evidence supporting *o*-phthalic acid biodegradation in water. These trusted data sources reported rapid primary and ultimate biodegradation of *o*-phthalic acid under aerobic conditions in water. These sources also reported *o*-phthalic acid's primary biodegradation of 86 to 100% in 2 hours ([Tang et al., 2017](#)), 99% in 1 day ([Saeger and Tucker, 1976](#)), and 100% in 14 days ([Fujita et al., 2005](#)). Additionally, two of the trusted data sources reported that higher concentrations of *o*-phthalic acid resulted in slower or incomplete primary biodegradation ([Tang et al., 2017](#); [Saeger and Tucker, 1976](#)). The reported primary and ultimate biodegradation half-lives ranged from 1 to less than 3 days and 9 to 18 days when seeded with sewage sludge, respectively ([Fujita et al., 2005](#); [Saeger and Tucker, 1976](#)). One of these sources reported ultimate biodegradation half-lives ranging from 11 to 37 days when seeded with river or pond water microbes ([Fujita et al., 2005](#)). These findings suggest *o*-phthalic acid to be readily biodegradable with an expected faster biodegradation in aerobic wastewater treatment processes than in the environment.

Three of the high-quality, trusted data sources ([Kleerebezem et al., 1999](#); [Battersby and Wilson, 1989](#); [Shelton and Tiedje, 1984](#)) and a medium-quality data source ([Levén and Schnürer, 2005](#)) reported *o*-phthalic acid to undergo 60% to complete mineralization under anaerobic conditions in water. [Kleerebezem \(1999\)](#) reported mineralization half-lives ranging between 7 to 49 days in anaerobic reactors seeded with sludge from three different full scale WWTPs. The study suggested that higher biodegradation is expected in the presence of granular biomass with high methanogenic activity. Similar studies reported  $78 \pm 36\%$  mineralization after 21 weeks ([Levén and Schnürer, 2005](#)) and complete mineralization after 4 weeks ([Battersby and Wilson, 1989](#)). [Shelton \(1984\)](#) reported 85% to complete mineralization and 60% to complete mineralization using different synthetic media and seeded with nine different wastewater sludge, respectively. Despite the wide range in biodegradation rates, most experimental conditions achieved complete mineralization in 8 weeks. In general, there is robust evidence to support that *o*-phthalic acid is expected to readily biodegrade under most environmental conditions with an environmental biodegradation half-life on the order of days but could persist longer than expected in anaerobic environmental compartments.

#### 4.1.2 Biodegradation in Soil and Landfill

The EPA extracted and evaluated five high-quality, trusted data sources containing a robust weight of evidence supporting *o*-phthalic acid biodegradation in soils and landfills ([Zhao et al., 2016](#); [Ortiz et al., 2003](#); [Evans, 1998](#); [Roslev et al., 1998](#); [Ejlertsson et al., 1996](#)). These sources reported 19.2% to complete mineralization of *o*-phthalic acid in soils under aerobic conditions with different pH, soil depths, *o*-phthalic acid initial concentrations, and presence of co-contaminants. Two of these sources reported 17.2 to 21.1% biodegradation in 30 days and 32% biodegradation in 2.1 days in soils under aerobic conditions with a pH of about 5 and 8.2, respectively ([Ortiz et al., 2003](#); [Evans, 1998](#)). These sources reported a nearly uniform biodegradation rate for *o*-phthalic acid within the topsoil layers (0–58 cm) at a pH of 5, higher biodegradation rates at pH of 8.5, and greater mineralization in the presence of toluene. Despite the lower biodegradation at pH 5, sludge-amended soils has been reported to achieve

faster biodegradation: 47% mineralization and initial half-life of 2 days at pH of 5.9 and 20 °C ([Roslev et al., 1998](#)). Similarly, the inoculation of soils with microbes isolated from a Chinese farm has been reported to achieve complete biodegradation of *o*-phthalic acid at concentrations equal or lower than 100 mg/L in 6 days or less under aerobic conditions ([Zhao et al., 2016](#)). The study reported *o*-phthalic acid biodegradation half-lives ranging from 0.6 to 7 days (500 mg/L) under aerobic conditions at initial concentrations of 25 to 500 mg/L, respectively. Anaerobic conditions resulted in 84% biodegradation at initial concentration of 25 mg/L *o*-phthalic acid and biodegradation half-lives 4 times higher than under aerobic conditions. However, one of the available trusted data sources reported complete mineralization of 50 mg/L *o*-phthalic acid in simulated anaerobic landfill conditions after 100 days and pH of 7 ([Ejlertsson et al., 1996](#)). In general, there is robust evidence to support that *o*-phthalic acid is expected to readily biodegrade in soils under most environmental conditions, might persist for extended periods of time in anaerobic environmental compartments, and has an environmental biodegradation half-life on the order of days to weeks.

#### 4.1.3 Biodegradation in Sediment

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The EPA extracted and evaluated three high quality trusted data sources containing a robust weight of evidence supporting *o*-phthalic acid biodegradation in sediments under anaerobic conditions ([Liu et al., 2005](#); [Liu and Chi, 2003](#); [MSU, 1981](#)). Two of these sources reported the 82.7% primary biodegradation after 44 days and 99% to complete mineralization after 8 weeks in sediments under anaerobic conditions ([Liu et al., 2005](#); [MSU, 1981](#)). The third source reported a complete primary biodegradation of 20 mg/L *o*-phthalic acid after 180 to 198-days incubation under anaerobic conditions with a CO<sub>2</sub>/H<sub>2</sub> atmosphere and 278 to 300 days incubation in a N<sub>2</sub> and in a N<sub>2</sub>/H<sub>2</sub> atmosphere ([Liu and Chi, 2003](#)). Based on this finding, the authors suggested that initial transformation step in the anaerobic biodegradation of *o*-phthalic acid to be dependent on the presence of CO<sub>2</sub> and H<sub>2</sub> within the compartment. In general, there is robust evidence to support that *o*-phthalic acid is expected to biodegrade in sediments under most environmental conditions with an expected environmental biodegradation half-life on the order of weeks.

#### 4.2 Photolysis

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*o*-Phthalic acid contains chromophores that absorb light at greater than 290 nm wavelength ([NCBI, 2020b](#)); therefore, direct photodegradation is a relevant degradation pathway for *o*-phthalic acid released to air. However, indirect photodegradation with hydroxyl radicals is expected to be more rapid in the atmosphere with a predicted half-life of 8.65 days ( $\cdot\text{OH}$  rate constant of  $1.237 \times 10^{-12} \text{ cm}^3/\text{molecule-second}$  and a 12-hour day with  $1.5 \times 10^6 \text{ OH}/\text{cm}^3$ ) ([U.S. EPA, 2017](#)). In water, photochemical degradation of *o*-phthalic acid is expected to be slower than air due to the typical light attenuation in natural surface water. The solar irradiation (18.4 KJ/cm<sup>2</sup>) of *o*-phthalic acid in distilled water has been reported to result in 4% photolysis after 15 days ([Bajt et al., 1992](#)). In general, there is a robust weight of evidence suggesting that *o*-phthalic acid is susceptible to photochemical decay in atmospheric air. However, photochemical decay is not expected to be a significant degradation process in surface water.

## 5 MEDIA ASSESSMENTS

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Phthalic anhydride is expected to rapidly hydrolyze into *o*-phthalic acid in the presence of water under normal environmental conditions. *o*-Phthalic acid has been reported to be present in the atmosphere, aquatic environments, and terrestrial environments. Once in the air, *o*-phthalic acid is expected to be partitioned to soils and surface water via wet deposition and have a short half-life in the atmosphere. Based on the physical and chemical properties, *o*-phthalic acid is likely to be present as house dust and airborne particles in the indoor environment and is expected to be present at higher concentrations indoors as compared to ambient (outdoor) air. Once in water, the Level III Fugacity Model in EPI Suite™ ([U.S. EPA, 2017](#)) predicts that close to 99% of the *o*-phthalic acid will remain in water (Section 3.2). However, *o*-phthalic acid is expected to readily biodegrade in most aquatic environments (Section 4.1.1). *o*-Phthalic acid is expected to have an aerobic biodegradation half-life of less than 3 days in water. In terrestrial environments, *o*-phthalic acid is expected to be highly mobile from soils and to rapidly migrate to groundwater. *o*-Phthalic acid in soils is expected to have a half-life on the order of days to weeks (based on the estimated half-life of 6 days) and have low bioaccumulation potential and biomagnification potential in terrestrial organisms. *o*-Phthalic acid is released to groundwater via wastewater effluent and landfill leachates, is expected to have a half-life of days, and is not likely to be persistent in most groundwater/subsurface environments.

### 5.1 Air and Atmosphere

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Phthalic anhydride is a solid at environmental temperatures with a melting point of 130.8°C ([DOE, 2016](#); [Haynes, 2014](#)) and a vapor pressure of  $5.17 \times 10^{-4}$  mmHg at 25°C ([NLM, 2015](#)). Based on the selected melting point and vapor pressure values, phthalic anhydride has a potential to be present in the atmosphere mostly as particulates (as dust) under normal environmental conditions. However, phthalic anhydride is expected to rapidly hydrolyze into *o*-phthalic acid with the moisture present in the atmosphere (Section 3). *o*-Phthalic acid is a solid at environmental temperatures with a melting point of 206.75°C ([Haynes, 2014](#); [Booth et al., 2012](#)) and a vapor pressure of  $6.36 \times 10^{-7}$  mmHg at 25°C ([U.S. EPA, 2020b](#)). Like phthalic anhydride, *o*-phthalic acid also has the potential to be present in the atmosphere mostly as particulates. *o*-Phthalic acid has a predicted photochemical half-life of 8.65 days in the atmosphere ([U.S. EPA, 2017](#)) but it is expected to be subject to wet and dry deposition reducing its persistence in air (Section 3.1.2).

The available trusted data sources have reported the presence of *o*-phthalic acid in aerosol and air dust samples collected in Canada, China, Japan, Spain, and India. In Canada, *o*-phthalic acid has been reported in aerosol samples collected near arctic sites at concentrations of about 2.16 and 3.8 ng/m<sup>3</sup> ([Fu et al., 2009](#)). The authors reported a strong correlation between the concentrations of *o*-phthalic acid and other phthalate esters. Phthalate esters have been reported to hydrolyze, in two hydrolytic steps, into *o*-phthalic acid ([Staples et al., 1997](#)). In China, *o*-phthalic acid was reported in dust samples collected at different stages of dust storms at concentrations of 24 to 102 ng/m<sup>3</sup> ([Ren et al., 2019](#)). The authors suggested that the presence of *o*-phthalic acids is an indicator of local anthropogenic sources near urban areas. In Japan, *o*-phthalic acid was reported on snow, rain, and aerosol samples collected from urban air in Tokyo at concentrations of 85 to 157 ng/m<sup>3</sup> ([Sempere and Kawamura, 1994](#)). In Spain, *o*-phthalic acid was reported in aerosol samples collected in schools from Barcelona at concentrations of 3 to 51 ng/m<sup>3</sup> ([van Drooge et al., 2020](#)). The authors reported *o*-phthalic acid to be present at higher concentrations in the aerosol samples collected indoors than outdoors. In India, *o*-phthalic acid was reported in aerosol samples collected near urban and landfill sites at concentrations of 123.95 and 186.04 ng/m<sup>3</sup>, respectively. In general, the weight of evidence within the available trusted data sources suggests that the presence of *o*-phthalic acid in air samples is associated with anthropogenic activities.

As noted previously, *o*-phthalic acid is expected to be removed from the atmosphere via dry and wet deposition. The presence of *o*-phthalic acid was reported in rainwater and snow samples collected in southern California, Arctic Canada, and Japan. In southern California, *o*-phthalic acid was detected in rain and snow samples at median concentrations of 7.14 and 46.52 µg/L in non-urban and urban sites, respectively ([Kawamura et al., 1996](#)). In Canada, *o*-phthalic acid was detected in snow at median concentrations of 1.1 and 0.9 µg/L for winter and spring samples, respectively ([Narukawa et al., 2002](#)). In Japan, *o*-phthalic acid was detected at concentrations of 2.25 to 4.07 µg/L and 0.38 to 30.7 µg/L in snow and rain samples, respectively ([Sempere and Kawamura, 1994](#)). These findings help support that *o*-phthalic acid present in the atmosphere is expected to be removed via wet deposition.

### 5.1.1 Indoor Air and Dust

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In general, phthalate esters are ubiquitous in the atmosphere and indoor air. Their worldwide presence in air has been documented in the gas phase, suspended particles, and dust ([Net et al., 2015](#)). There is limited information on the presence of *o*-phthalic acid under indoor settings and dust. Drooge ([2020](#)) reported *o*-phthalic acid to be present at concentrations of  $42 \pm 33$  ng/m<sup>3</sup> to  $51 \pm 33$  ng/m<sup>3</sup> in indoor aerosol samples collected from schools in Spain. The study reported the *o*-phthalic acid concentration within the air samples collected from indoors was more than 10 times higher than those collected outdoors. The authors suggested that the presence of *o*-phthalic acid and other organic chemicals to be related to their release into the atmosphere from anthropogenic activities within the schools, such as the use of plastic classroom materials. In general, *o*-phthalic acid is expected to be present in air as a particulate or dust (Sections 2.2.1, 2.2.2, and 2.2.4), and is expected to be deposited on the available surface areas within indoor settings (based on the fugacity of air releases as described in Section 3.2.1). *o*-Phthalic acid was also detected at higher concentrations under the indoor settings where the presence of materials containing *o*-phthalic acid and its precursors are more prevalent.

## 5.2 Aquatic Environments

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### 5.2.1 Surface Water

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Phthalic anhydride is expected to be released to the surface water via industrial and municipal WWTP effluent, surface water runoff, and, to a lesser degree—atmospheric deposition. Phthalic anhydride was detected in 17.6% of the 85 surface water samples collected from 139 streams within the United States ([Kolpin et al., 2002](#)). The reported maximum and median concentrations of phthalic anhydride are 1 and 0.7 µg/L, respectively. However, phthalic anhydride is expected to rapidly hydrolyze into *o*-phthalic acid and the reported concentrations of phthalic anhydride in these water samples could be an artifact of the transformation of *o*-phthalic acid and other phthalate esters observed via gas chromatography ([Tankiewicz et al., 2019](#); [Vainiotalo and Pfaffli, 1990](#)). Therefore, it is uncertain whether the results truly represent the presence of phthalic anhydride as *o*-phthalic acid in surface water. However, *o*-phthalic acid present in surface water is not expected to partition to sediment or air (Sections 5.2.2 and 2.2.2), has an expected biodegradation half-life of days (Section 4.1.1), and is not expected to bioaccumulate in aquatic organisms (Section 7).

### 5.2.2 Sediments

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In the presence of water, phthalic anhydride is expected to rapidly hydrolyze to *o*-phthalic acid; thus, it is not expected to be present in sediments under normal environmental conditions. *o*-Phthalic acid is a very soluble chemical substance (Section 2.2.6), is not likely to partition to suspended organic matter, and is not expected to sorb onto sediments (Section 3.1.1). The Level III Fugacity modeling results indicated a negligible partitioning of *o*-phthalic acid in sediments (Section 3.2.1). Any *o*-phthalic acid present in sediments is expected to biodegrade within weeks (Section 4.1.3).

## 5.3 Terrestrial Environment

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### 5.3.1 Biosolids

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Sludge is defined as the solid, semi-solid, or liquid residue generated by wastewater treatment processes. The term “biosolids” refers to treated sludge that meets the EPA pollutant and pathogen requirements for land application and surface disposal and can be beneficially recycled (40 CFR part 503) ([U.S. EPA, 1993](#)). Typically, chemical substances with very low water solubility and high sorption potential are expected to be sorbed to suspended solids and efficiently removed from wastewater via accumulation in sewage sludge and biosolids.

During wastewater treatment, phthalic anhydride will rapidly hydrolyze into *o*-phthalic acid. Because *o*-phthalic acid is very soluble in water, it is not expected to partition to suspended organic matter or biosolids (Sections 3.1 and 3.2.1). Sorption of *o*-phthalic acid into biosolids is predicted to account for 2% of the overall removal during wastewater treatment ([U.S. EPA, 2017](#)). Based on the rapid biodegradation in soils and landfills, *o*-phthalic acid is expected to have a biodegradation half-life of days to weeks in biosolids. Once in biosolids, *o*-phthalic acid could be transferred to soil during land applications.

### 5.3.2 Soil

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Phthalic anhydride as *o*-phthalic acid is expected to be deposited to soil via atmospheric wet and dry deposition from air emissions. Phthalic anhydride as *o*-phthalic acid in biosolids is unlikely; however, *o*-phthalic acid can be present in biosolids and sludge as a degradation product of other phthalate esters. Based on *o*-phthalic acid’s log HLC (atm×m<sup>3</sup>/mol) of lower than -10 at 25 °C and vapor pressure of 6.4×10<sup>-7</sup> mmHg, *o*-phthalic acid is not likely to volatilize from soils. It is also not expected to be sorbed to organic matter in soil (log K<sub>oc</sub> [L/kg] = 1.07 and log K<sub>ow</sub> = 0.73 [Table 3-1]). These properties indicate that *o*-phthalic acid is expected to have high mobility in soil environments. As described in Section 3.1.1, *o*-phthalic acid present in soil is expected to rapidly migrate to groundwater and have a biodegradation half-life of days to weeks (Section 4.1) in soils. It is not expected to bioaccumulate or biomagnify in terrestrial and aquatic organisms.

### 5.3.3 Landfills

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Landfills have been reported to receive incoming waste containing 20 to 30% moisture ([Gen et al., 2023](#)); thus, phthalic anhydride will rapidly hydrolyze into *o*-phthalic acid under these conditions. For the purpose of this draft assessment, landfills will be considered to be divided into two zones: (1) an “upper-landfill” zone, with the normal environmental temperatures and pressures, where biotic processes are the predominant route of degradation for *o*-phthalic acid; and (2) a “lower-landfill” zone where elevated temperatures and pressures exist, and abiotic degradation is the predominant route of degradation for *o*-phthalic acid. In the upper-landfill zone, where oxygen might still be present in the subsurface, conditions may still be favorable for aerobic biodegradation; however, photolysis and hydrolysis are not considered to be significant sources of degradation in this zone. In the lower-landfill zone, conditions are assumed to be anoxic and temperatures in this zone are likely to inhibit biotic degradation of *o*-phthalic acid. In the lower-landfill zones, there is some evidence to support that hydrolysis may be the main route of abiotic degradation of phthalate esters ([Huang et al., 2013](#); [Jonsson et al., 2003a](#)). Temperatures in the lower-landfill zones may be as high as 70 °C ([Huang et al., 2013](#)). For temperatures at and above 60 °C, biotic processes are significantly inhibited and are likely to be irrelevant at 70 °C ([Huang et al., 2013](#)).

EPA identified the condition of use (COU) under TSCA associated with commercial and consumer products that are expected to continually introduce phthalic anhydride into landfills. These COUs

include the use and disposal of adhesives, sealants, arts, crafts, hobby materials, paints and coatings as described in the *Draft Consumer and Indoor Exposure Assessment for Phthalic Anhydride* ([U.S. EPA, 2026a](#)). As previously described, once released, the chemical will rapidly hydrolyze into and be present in landfills as *o*-phthalic acid. In turn, *o*-Phthalic acid is expected to have negligible sorption to organic content in landfills and will rapidly migrate to landfill leachate and groundwater (Section 3.1). The presence of *o*-phthalic acid in landfill leachates has been reported at maximum concentrations of 45, 260, 880, and 19,000 µg/L in Germany, Denmark, Sweden, and Italy, respectively ([Esmaeili Nasrabadi et al., 2024](#); [Jonsson et al., 2003b](#)). However, the presence of *o*-phthalic acid has been reported to be associated with hydrolysis of phthalate esters in landfills ([Jonsson et al., 2003a](#)). In addition, *o*-phthalic acid has been reported to be naturally produced within the environment ([Huang et al., 2021](#)) and might not reflect the expected occurrence of phthalic anhydride in landfills. In general, phthalic anhydride is expected to be rapidly hydrolyzed into *o*-phthalic acid and rapidly migrate to groundwater. *o*-Phthalic acid in groundwater is expected to have a biodegradation half-life of days and not likely to bioaccumulate in aquatic organisms under normal environmental conditions once groundwater has been discharged to surface water.

#### 5.3.4 Groundwater

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Phthalic anhydride is not expected to be present in groundwater as it is expected to hydrolyze to *o*-phthalic acid. There are several potential sources of *o*-phthalic acid in groundwater, including wastewater effluents and landfill leachates, which are discussed in Sections 6.2 and 5.3.3. Furthermore, in environments where *o*-phthalic acid is found in surface water, it may enter groundwater through surface water/groundwater interactions. Diffuse sources include storm water runoff and runoff from biosolids applied to agricultural land.

Given the weak affinity of *o*-phthalic acid to adsorb to organic matter present in soils and sediments ( $\log K_{oc}$  [L/kg] = 1.07) ([NCBI, 2020b](#)) and high solubility in water (6,994 mg/L) ([U.S. EPA, 2020b](#)), *o*-phthalic acid is expected to have high mobility in soil. *o*-Phthalic acid in groundwater is expected to have a biodegradation half-life of days and not likely to bioaccumulate on aquatic organisms under normal environmental conditions.

## 6 REMOVAL AND PERSISTENCE POTENTIAL

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As described in Section 3, phthalic anhydride is expected to rapidly hydrolyze into *o*-phthalic acid. *o*-Phthalic acid is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions with environmental biodegradation half-life on the order of days to weeks (Section 4). In the atmosphere, *o*-phthalic acid is expected to undergo photolytic degradation through reaction with atmospheric hydroxyl radicals, with an estimated half-life of 8.65 days, and subjected to wet and dry deposition. Based on its high solubility in water and low sorption potential, deposited *o*-phthalic acid is expected to partition to aquatic environments. The available trusted data sources suggest that the incineration will potentially remove up to 99% of *o*-phthalic acid. It was reported that the wastewater and drinking water treatment processes partially remove *o*-phthalic acid from water. However, *o*-phthalic acid is not expected to persist or bioaccumulate in aquatic and terrestrial organisms.

### 6.1 Destruction and Removal Efficiency

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Destruction and removal efficiency (DRE) is a percentage that represents the mass of a pollutant removed through or destroyed in a thermal incinerator relative to the mass that entered the system. Phthalic anhydride is classified as a hazardous substance and EPA requires that hazardous waste incineration systems destroy and remove at least 99.99% of each harmful chemical in the waste, including treated hazardous waste (46 FR 7684) ([Federal Register, 1981](#)).

Currently, there is limited information reasonably available on the DRE of phthalic anhydride and *o*-phthalic acid. The available trusted data sources reported the use of direct incineration or with the combination of scrubbers and preheating processes to enhance the phthalic anhydride removal efficiency. Patterson ([1976](#)) reported that 92% removal efficiency was achieved with the use of direct incineration and 99% removal when incineration was combined with water scrubbers. Hughes ([1979](#)) reported that 96.5% removal achieved during the incineration of phthalic anhydride at 700 °C when combined with wet scrubbers. The same study suggested that a temperature higher than 860 °C to achieve 99% removal efficiencies, based on phthalic anhydride activation energy. These findings suggest that the use of wet scrubbers and a temperature of 860 °C or higher is needed to supply the activation energy needed to achieve 99% removal of phthalic anhydride. In general, the available trusted data sources suggest that incineration has the potential to remove up to 99% of phthalic anhydride with a small fraction released to landfills and air. Based on its water solubility and sorption potential, phthalic anhydride released to landfills or air is expected to rapidly hydrolyze into *o*-phthalic acid and partition to aquatic environments.

### 6.2 Removal in Wastewater Treatment

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Wastewater treatment is performed to remove contaminants from wastewater using physical, biological, and chemical processes. Generally, municipal wastewater treatment facilities apply primary and secondary treatment processes. During the primary treatment, screens, grit chambers, and settling tanks are used to remove solids from wastewater. After undergoing primary treatment, the wastewater undergoes secondary treatment. Secondary treatment processes can remove up to 90% of the organic matter in wastewater using biological treatment processes such as trickling filters or activated sludge. The estimated median hydraulic detention time of municipal wastewater treatment plants in the United States is 1.4 days, based on the design capacities and historical daily flows of 50 POTW facilities ([U.S. EPA, 1982](#)). Sometimes an additional stage of treatment such as tertiary treatment is utilized to further clean the water for additional protection using advanced treatment techniques (e.g., ozonation, chlorination, disinfection) ([U.S. EPA, 1998](#)).

Very limited reasonably available information is available on the fate and transport of *o*-phthalic acid in wastewater treatment systems. In general, a chemical may be removed from a wastewater treatment plant via sorption to sludge, stripping to air, biodegradation, or hydrolysis. The removal efficiency of these processes is influenced by the chemical substance's physical-chemical properties, chemical structure, and treatment time. As described in Sections 3.1 and 3.2.1, *o*-phthalic acid is highly soluble in water, and it's not expected to volatilize or partition to organic suspended organic matter. The predicted removal of *o*-phthalic acid from wastewater via sorption processes is less than 2% (U.S. EPA, 2017). However, based on the reported wastewater hydraulic detention times within the United States (U.S. EPA, 1982) and *o*-phthalic acid reported half-life of less than 3 days, biodegradation could potentially contribute to 10 to 20% of *o*-phthalic acid removal from wastewater. Kotowska (2012) reported the presence of *o*-phthalic acid in the influent and effluent of samples collected from a wastewater treatment facility in Poland. That study reported a 20% removal of *o*-phthalic acid from wastewater. Pirsahab (2009) reported increased hydraulic retention times resulted in higher removal efficiencies of *o*-phthalic acid on a bench scale aerobic biofilm reactor. The study reported greater than 96% and greater than 99% biodegradations of *o*-phthalic acid from synthetic wastewater and hydraulic retention times of 12 hours and 24 hours, respectively. In general, the available trusted data sources suggest that biodegradation is the main removal mechanism of *o*-phthalic acid during municipal wastewater treatment processes with an expected removal of 10 to 20%.

### 6.3 Removal in Drinking Water Treatment

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Drinking water in the United States typically comes from the surface water (*i.e.*, lakes, rivers, reservoirs) and groundwater. The source water then flows to a treatment plant where it undergoes a series of water treatment steps before being dispersed to homes and communities. In the United States, public water systems often use conventional treatment processes that include coagulation, flocculation, sedimentation, filtration, and disinfection, as required by federal and state law.

A data source providing information on the removal of *o*-phthalic acid in drinking water treatment was not identified during the EPA's systematic review of the relevant literature. In general, adsorption and separation treatment processes are considered some of the most efficient methods for the removal of phthalates from water (Khan et al., 2015). However, due to *o*-phthalic acid low sorption potential (Section 2.2.7), high water solubility (Section 2.2.6), and rapid dissociation in water (Section 2.2.13), *o*-phthalic acid is not expected to be efficiently removed with treatment processes that are based on chemical adsorption and/or separation processes. In general, there is robust evidence suggesting that *o*-phthalic acid is not expected to be efficiently removed during conventional drinking water treatment.

## 7 BIOACCUMULATION POTENTIAL

As described in Section 3, phthalic anhydride is expected to rapidly hydrolyze into *o*-phthalic acid; therefore, this section focuses on *o*-phthalic acid. *o*-Phthalic acid is ubiquitous in the environment and has been detected in urban ambient air, dust, soil and sediment samples collected in Southern California (Fraser et al., 2003; Kawamuras and Kaplan, 1987). Despite the ubiquitous presence, the reported physical and chemical properties of *o*-phthalic acid suggest that it acid is likely to rapidly biodegrade and not likely to bioaccumulate under normal environmental conditions (Section 2.1). There is limited experimental information for the bioaccumulation potential of *o*-phthalic acid. However, the available trusted data sources suggest that it is not likely to bioaccumulate based on predicted BCF and BAF values (U.S. EPA, 2020b; OECD, 2005; U.S. EPA, 1986). These sources reported the model predicted BCF values of 2 L/kg, 2.49 L/kg, and 3.2 L/kg based on *o*-phthalic acid's Kow. These predicted BCF values suggest that *o*-phthalic acid is not expected to significantly bioaccumulate within the environmental compartments. This conclusion is supported by the reported model predicted BAF value of 1.32 L/kg (U.S. EPA, 2020b). Overall, there is a robust weight of evidence suggesting that *o*-phthalic acid is not expected to bioaccumulate in aquatic and terrestrial organisms.

**Table 7-1. Summary of Bioaccumulation Information of *o*-Phthalic Acid**

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Aquatic bioconcentration factor (BCF)	3.2 L/kg, calculated from the octanol-water partition coefficients (log Kow = 0.73)	<a href="#">OECD (2005)</a>	High
	2.49 L/kg	<a href="#">U.S. EPA (2020b)</a>	High
Aquatic bioaccumulation factor (BAF)	1.32 L/kg	<a href="#">U.S. EPA (2020b)</a>	High

## 8 WEIGHT OF SCIENTIFIC EVIDENCE CONCLUSIONS FOR FATE AND TRANSPORT

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### 8.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Fate and Transport Assessment

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Findings supported by one or more high-quality studies with a high degree of agreement with each other were considered to have a robust weight of evidence. Findings supported by a mix of high- and medium-quality studies with a high degree of agreement with each other but varied in sample size and consistency were considered to have a moderate weight of evidence. High-quality measured and experimentally derived fate properties were selected whenever possible. When no data were available, peer-reviewed models such as EPI Suite™ and QSPR models were used to estimate the parameter values. These values are not as strong as those experimentally derived, but EPA has high confidence in their selection. High-quality field data was used to support the findings of the analyses wherever possible.

Given the consistent results from numerous high-quality studies, there is robust confidence that phthalic anhydride will rapidly hydrolyze into *o*-phthalic acid in the presence of moisture, and that *o*-phthalic acid:

- has chromophores that absorb in the visible range of the solar light spectrum and is expected to undergo direct and indirect photolysis (Section 4.2);
- is expected to be present in the atmosphere mostly as suspended particles (Section 5.1);
- will biodegrade in aerobic surface water, soil, groundwater, landfills, and wastewater treatment processes (Sections 4.1, 5.3.2, 6.2);
- will not be efficiently removed during sorption-based wastewater treatment, expected to be partially removed (10–20%) during aerobic biodegradation (based on mean hydraulic retention times of 50 POTWs in the United States), and with a major fraction being present in effluent (Section 6.2);
- will not bioaccumulate (Section 7);
- is not expected to be efficiently removed during conventional drinking water treatment (Section 6.3); and
- is expected to have negligible sorption to organic content in landfills and will rapidly migrate to landfill leachate and ground water (Section 5.3.3).

## 9 CONCLUSIONS FOR THE PHYSICAL CHEMISTRY AND FATE AND TRANSPORT ASSESSMENT

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The inherent physical-chemical properties of *o*-phthalic acid govern its environmental fate and transport. Based on *o*-phthalic acid's aqueous solubility and low tendency to adsorb to organic carbon, *o*-phthalic acid will preferentially be partition to surface water and groundwater. Soil, sediment, and sludge/biosolids are predicted to be the minor receiving compartments for *o*-phthalic acid as indicated in the assessment of *o*-phthalic acid's physical-chemical and fate properties and supported by the information obtained from the fugacity assessment and monitoring studies. The weight of scientific evidence indicates that surface water is predicted to be a major pathway, and the main receiving compartment for *o*-phthalic acid discharged via wastewater treatment processes. However, *o*-phthalic acid in surface water is expected to biodegrade in the order of days. While *o*-phthalic acid undergoes rapid aerobic biodegradation, the presence of phthalate esters in anoxic/anaerobic environments (sediment, landfills) have been reported to slowly hydrolyze into *o*-phthalic acid ([Chang et al., 2005](#)). Therefore, it is difficult to determine whether the source of *o*-phthalic acid in the environment is due to phthalic anhydride or the presence of phthalate esters.

If released directly into the atmosphere, *o*-phthalic acid is expected to be present as suspended particles or dust and not as a vapor. It is not expected to undergo long-range transport facilitated by particulate matter due to photolysis and wet and dry deposition. In indoor settings, *o*-phthalic acid released to air is expected to be present as dust. The available information suggests that *o*-phthalic acid's indoor dust concentrations are associated with the presence of consumer products containing phthalate esters. Atmospheric concentrations of *o*-phthalic acid may be elevated proximal (close) to sites where phthalic anhydride and other phthalate esters are released. Off-gassing from landfills and volatilization from wastewater treatment processes are expected to be negligible releases in terms of ecological or human exposure in the environment due to its low vapor pressure.

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