

# **Human Health Hazard Assessment**

**Diisooctyl Phthalate (DIOP)**  
**(CAS No. 27554-26-3)**

**TABLE OF CONTENTS**

INTRODUCTION .....	3
1. IDENTITY .....	3
1.1 Identification of the Substance.....	3
1.2 Physicochemical Properties .....	3
2. USES.....	4
3. HUMAN HEALTH HAZARD .....	4
3.1 Toxicokinetics.....	4
3.2 Acute Toxicity .....	5
3.3 Irritation .....	5
3.4 Sensitisation .....	6
3.5 Repeated Dose Toxicity .....	6
3.6 Genetic Toxicity.....	7
3.7 Carcinogenicity .....	8
3.8 Reproductive Toxicity .....	8
3.8.1 Mode of action .....	8
4. HAZARD CHARACTERISATION.....	10
5. HUMAN HEALTH HAZARD SUMMARY TABLE .....	12
6. REFERENCES .....	13

## INTRODUCTION

This review of diisooctyl phthalate (DIOP) is a health hazard assessment only. For this assessment, a BIBRA Toxicity Profile (BIBRA, 1989) and an ECB IUCLID Dataset on DIOP (ECB, 2000) were consulted. Information from these documents was supplemented with relevant studies from more recent literature surveys conducted up to September 2006.

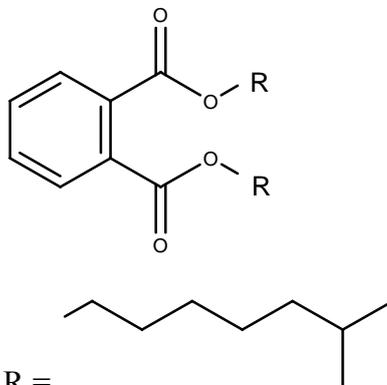
References not marked with an asterisk were examined for the purposes of this assessment. References not examined but quoted from the key report as secondary citations are also noted in this assessment and marked with an asterisk. It should be noted that the data in the IUCLID are data reported by the European Chemicals Industry and have not undergone review by the European Commission.

Hazard information from this assessment is published also in the form of a hazard compendium providing a comparative analysis of key toxicity endpoints for 25 phthalates (NICNAS, 2007a).

## 1. IDENTITY

### 1.1 Identification of the Substance

CAS Number: 27554-26-3  
 Chemical Name: 1,2-Benzenedicarboxylic acid, diisooctyl ester  
 Common Name: Diisooctyl phthalate (DIOP)  
 Molecular Formula: C<sub>24</sub>H<sub>38</sub>O<sub>4</sub>  
 Structural Formula:



Molecular Weight: 390.62  
 Synonyms: Diisooctyl 1,2-benzenedicarboxylate; Phthalic acid, diisooctyl ester  
 Purity/Impurities/Additives: Not available

### 1.2 Physicochemical Properties

**Table 1: Summary of physicochemical properties**

<i>Property</i>	<i>Value</i>
Physical state	Oily liquid
Melting point	-45°C
Boiling point	230°C (0.53 kPa)
Density	986 kg/m <sup>3</sup> (20°C)

Vapour pressure	1.33 kPa (200°C)
Water solubility	<0.1 g/L (20°C)
Partition coefficient n-octanol/water (log Kow)	Not available
Henry's law constant	Not available
Flash point (closed cup)	227°C

Source: BIBRA (1989) and ECB (2000)

## 2. USES

Overseas use information was not available.

In Australia, DIOP is imported for the manufacture of rubber compounds for automotive hoses and parts. The chemical is also distributed to various institutions and laboratories for biotechnological and pharmaceutical research.

## 3. HUMAN HEALTH HAZARD

### 3.1 Toxicokinetics

#### *Previous Evaluations*

Ikeda et al. (1978) showed complete excretion of <sup>14</sup>C-DIOP in the urine and faeces within 4 to 21 days following dietary administration in rats, dogs and pigs. In the study, male rats, dogs and miniature pigs were given 50 mg/kg bw/d DIOP in the diet for 21-28 days before oral administration (by stomach tube) of a single radioactively labelled dose. In the rat, approximately half the labelled compound was excreted in the urine and half in the faeces, with 85% of the dose excreted after 24 h and virtually all of it within 4 days. In the dog, 69-80% appeared in the faeces, whilst in pigs 65-86% was eliminated in the urine. Only about 50% had been excreted by the dogs and pigs after 24 hours, and complete elimination by dogs took 4 days and by pigs took 21 days. A small distribution to body fat occurred in all 3 species, and the investigators suggested that a slower release of DIOP from body fat and subsequent metabolism may have accounted for the slower excretion rate in pigs (Ikeda et al., 1978).

#### *Data not Reported in Previous Evaluations*

The metabolism of DIOP was monitored in humans by administering a single isotope-labelled dose containing butylbenzyl phthalate (BBP), dibutyl phthalate (DBP), diethylhexyl phthalate (DEHP), and diisooctyl phthalate (DIOP) to 24 volunteers. Eight volunteers received control, eight received low dose (including DIOP, 168 µg), and eight received high dose (including DIOP, 336 µg). Urine samples were collected at 1 day before dosing and 1, 2, 6 days after the dose was administered. The bulk of all labelled phthalates were eliminated in urine as the respective monoester metabolites within the first 24 hours. Approximately, 14 and 12% of the low and high dose was excreted as mono-octyl phthalate, respectively (Anderson et al., 2001), as measure of DEHP and DIOP metabolism.

## Conclusion

In humans, DIOP is in part eliminated in urine in the form of its monoester, mono-octyl phthalate. Near complete excretion of DIOP in the urine and faeces was noted between 4 and 21 days following dietary administration in rats, dogs and pigs. Apart from a small amount

distributed to fat within this timeframe, no significant tissue accumulation of DIOP was found in experimental animals.

### 3.2 Acute Toxicity

<i>Study</i>	<i>Species</i>	<i>Results (LD50/LC50)</i>	<i>References</i>
Oral	Rat	>22000 mg/kg bw/d	WR Grace & Co., 1948*; Tatsuno, 1975*
	Mouse	>26000 mg/kg bw	Tatsuno, 1975*
Dermal	Rabbit	>3160 mg/kg bw	Biodynamics Inc, 1981

\* From BIBRA (1989)

### Conclusion

DIOP has low acute oral and dermal toxicity in laboratory animals. No acute toxicity data from inhalation exposure or human studies were available for DIOP.

### 3.3 Irritation

#### Skin Irritation

##### *Previous Evaluations*

No data.

##### *Data not Reported in Previous Evaluations*

DIOP was reported to be slightly irritating to the rabbit skin in an unpublished study (ICI Chemical & Polymers, 1965\*, cited in ECB, 2000), however no information on dosage or time of exposure was available.

Also in another unpublished skin irritation study (ICI Chemicals & Polymers, 1958\*, cited in ECB, 2000), dermal application of undiluted DIOP to male rats for 24 hours, plus 6 applications on alternate days caused no skin irritation. No information on dose was available.

Doses of 50, 200, 794 and 3160 mg/kg bw DIOP were applied to the exposed skin of NZ White Albino rabbits (2/sex/dose). The application site was occluded for a total exposure of 24 hours. Observations for erythema or other evidence of skin irritation or injury were made approximately 30 minutes after removal of the occlusive wrapping and again at day 3, 7, 10 and 14. There were no signs of skin irritation in almost all animals at 50 and 200 mg/kg bw. Most animals at the 794 mg/kg dose level exhibited well defined erythema at 24 h only. At 3160 mg/kg dose level, very slight to severe skin irritation was noted in all animals at 24 h and on day 3, and two animals continued to exhibit very slight erythema on day 7 but not subsequently. Only one animal at the highest dose exhibited slight oedema (on day 3) (Biodynamics Inc, 1981).

### Conclusion

DIOP caused minimal skin irritation in rabbits.

### Eye Irritation

#### *Previous Evaluations*

No data.

#### *Data not Reported in Previous Evaluations*

An unpublished study in rabbits (ICI Chemicals & Polymers, 1958\*, cited in ECB, 2000) stated that one drop of undiluted DIOP compound applied to the conjunctival sac did not cause irritation.

### **Conclusion**

DIOP is reported not to cause eye irritation in rabbits, no further details available.

### Respiratory Irritation

#### *Previous Evaluations*

No data.

#### *Data not Reported in Previous Evaluations*

No data.

### **Conclusion**

No respiratory irritation studies were available for assessment.

### **3.4 Sensitisation**

#### *Previous Evaluations*

No data.

#### *Data not Reported in Previous Evaluations*

No data.

### **Conclusion**

No sensitisation studies were available for assessment.

### **3.5 Repeated Dose Toxicity**

#### *Previous Evaluations*

No data.

#### *Data not Reported in Previous Evaluations*

Several unpublished studies for repeated dose toxicity in experimental animals were reported in the IUCLID database (ECB, 2000) and the available details are listed in the table below.

<b><i>Exposure Routes, Species &amp; Duration</i></b>	<b><i>Doses (mg/kg bw/d)</i></b>	<b><i>Remarks</i></b>	<b><i>References</i></b>
Oral, Rat, 4 weeks	0, 100	Reported NOAEL of 100 mg/kg bw/d No further data available	Shibko & Blumenthal, 1973
Oral, Rat, 15-21 months, 3-5 generations	0, 100, 300, 500	No effects on growth	Lefaux, 1972*
Oral, Rat, 8 days	0, 1000	No effects or deaths reported. No abnormalities observed following blood, post mortem and histological examination.	ICI Chemicals & Polymers, 1958*
Oral, Dog, 14 weeks	0, 100	Reported NOAEL of 100 mg/kg bw/d No further data available	Shibko & Blumenthal, 1973
Subcutaneous, Rat, 7 days	0, 1000	No adverse effects other than some swelling at the site of injection. No abnormalities observed following blood, post mortem and histological examination.	ICI Chemicals & Polymers, 1958*

### Human Studies

BIBRA (1989) notes a Russian study (Milkov et al., 1973\*) describing exposure of leather workers to mixed phthalates, including periodically DIOP. Complaints of pain, numbness and spasms in hands of feet, polyneuritis and ear effects in of workers employed for 6 or more years were noted. Ambient air concentrations of phthalate mixtures were reported as 1.7 to 66 mg/m<sup>3</sup>. No further details were provided from which to determine DIOP-specific effects.

### **Conclusion**

In poorly detailed summaries, repeated dose exposure to DIOP was not associated with any apparent changes of toxicological significance in rats and dogs. A multigenerational study in rats noted no effects on growth. Short-term 7-8 day studies in rats noted no abnormalities including a lack of effects on mortality, growth, blood profile or histological findings.

The lack of details from these animal studies does not allow the determination of a repeated dose NOAEL or LOAEL for DIOP.

### **3.6 Genetic Toxicity**

#### *Previous Evaluations*

DIOP was weakly mutagenic in the presence, but not in the absence, of a liver metabolic activation system in a modified Ames test using *S. typhimurium* (strains not specified). The results were considered equivocal as no consistent dose-related response was seen and the mutagenic activity only occurred within a narrow concentration range (Grasso, 1978\*).

*Data not Reported in Previous Evaluations*

No mutagenic activity was detected in an Ames test using *S. typhimurium* (TA98, 100, 1535, and 1537) at DIOP concentrations of 10 to 2000 µg/plate, with and without metabolic activation (USS Chemical, year not stated\*).

**Conclusion**

DIOP tested negative in one Ames study (with and without metabolic activation) and weakly positive in another (with metabolic activation). Results of the latter test were considered equivocal as no consistent dose-related response was seen and the mutagenic activity only occurred within a narrow concentration range.

No *in vitro* cytogenetic, mammalian mutation and *in vivo* genotoxicity data were available for DIOP.

**3.7 Carcinogenicity***Previous Evaluations*

No data.

*Data not Reported in Previous Evaluations*

DIOP was tested in an *in vitro* Balb/3T3 mammalian cell transformation assay. DIOP did not induce the appearance of a significant number of transformed foci over the concentration range of 0.13 µl/ml to 42.4 µg/mL and was considered to be inactive under the condition of this test (Litton Bionetics, 1981).

**Conclusion**

DIOP was inactive in a single *in vitro* mammalian cell transformation assay. No *in vivo* carcinogenicity data were available for DIOP.

**3.8 Reproductive Toxicity***Previous Evaluations*

No data.

*Data not Reported in Previous Evaluations*

No data.

**3.8.1 Mode of action**

DIOP was negative for oestrogenic activity in a yeast 2-hybrid assay (Nishihara et al., 2000).

**Conclusion**

*Effects on fertility*

No reproductive toxicity studies were available for assessment.

*Effects on development*

No developmental toxicity studies were available for assessment.

#### 4. HAZARD CHARACTERISATION

Toxicity data for DIOP were not available for many health endpoints. For endpoints with missing or incomplete data, information from structurally similar phthalates, where available, was used to extrapolate potential toxicity. Relevant read-across information was obtained from other NICNAS assessment reports for relevant phthalates and the NICNAS Phthalates Hazard Compendium (2007a) which contains a comparative analysis of toxicity endpoints across 25 phthalates, including DIOP.

DIOP has a straight-chain carbon backbone of 7 and is considered to belong to the High Molecular Weight Phthalate Esters (HMWPEs) Category as defined by the Phthalate Esters Panel HPV Testing Group (2001) and OECD (2004). The HMWPE group includes chemically similar substances produced from alcohols having backbone carbon lengths of  $\geq$  C7. Due to their similar chemical structure, category members are generally similar with respect to physicochemical, biological and toxicological properties or display an expected trend. Thus, read-across for toxicity endpoints is an appropriate approach to characterise selected endpoints for members of this category.

DIOP is metabolised and cleared rapidly following ingestion in humans and eliminated in urine in part as mono-octyl phthalate. Near complete excretion of DIOP in the urine and faeces was noted between 4 and 21 days following dietary administration in rats, dogs and pigs. No significant tissue accumulation of DIOP was found in experimental animals.

DIOP has low acute oral and dermal toxicity. No inhalation toxicity studies are available for DIOP. Based on data for other HMWPEs, DIOP is expected to have low acute inhalation toxicity. DIOP causes minimal irritation when applied dermally to rabbits and reportedly does not cause irritation to rabbit eyes, however no details were available. Based on results from other phthalates, DIOP is unlikely to cause skin sensitisation.

Poorly detailed summaries of studies in rats and dogs noted that short-term repeated exposure (up to 1000 mg/kg bw/d) to DIOP is not associated with any apparent changes of toxicological significance. A multigenerational study in rats noted no effects on growth. Short-term 7-8 day studies in rats noted no abnormalities including a lack of effects on mortality, growth, blood profile or histological findings. The lack of details from these summaries does not allow the determination of a repeated dose NOAEL or LOAEL for DIOP.

DIOP tested negative in one Ames study (with and without metabolic activation) and weakly positive in another (with metabolic activation). Results of the latter test were considered equivocal. Its closely related analogue, a linear C8 phthalate DnOP, is negative in mutation and DNA damage assays (NICNAS, 2007b). In addition, based on the negative mutagenicity data for the HMWPE Category as a whole, including data on the 7 phthalates reviewed in the NICNAS Phthalate Hazard Compendium (NICNAS, 2007a) and other high molecular weight phthalates reviewed by the Phthalate Esters Panel HPV Testing Group (2001) and OECD (2004), DIOP is considered unlikely to be genotoxic.

No *in vivo* carcinogenicity data are available for DIOP. DIOP was considered inactive in an *in vitro* mammalian cell transformation assay. Due to insufficient testing on other phthalates, it is not possible to extrapolate carcinogenic potential for DIOP.

There are no reproductive or developmental toxicity studies for DIOP. DIOP was negative for oestrogenic activity in a yeast 2-hybrid assay. When assessed together, and noting none of the high molecular weight phthalates reviewed by NICNAS affected fertility or other aspects of the male reproductive system or induced developmental effects (NICNAS, 2007a), DIOP is considered unlikely to affect fertility and development.

**5. HUMAN HEALTH HAZARD SUMMARY TABLE**

<b><i>Phthalate</i></b>	<b><i>Acute Toxicity</i></b>	<b><i>Irritation &amp; Sensitisation</i></b>	<b><i>Repeated Dose Toxicity</i></b>	<b><i>Genetic Toxicity</i></b>	<b><i>Carcinogenicity</i></b>	<b><i>Fertility</i></b>	<b><i>Developmental Toxicity</i></b>
Diisooctyl phthalate (DIOP)	Oral Rat: LD50 > 22000 mg/kg bw  Dermal Rabbit: LD50 > 3160 mg/kg bw  Inhalation No data	Skin irritation: Minimal effects  Eye irritation: negative  Respiratory irritation: No data  Skin sensitisation: No data	Insufficient data	<i>In vitro</i> Negative in bacterial assay  <i>In vivo</i> No data	<i>In vitro</i> Negative in cell transformation assay  <i>In vivo</i> No data	No data	No data

## 6. REFERENCES

- Anderson WAC, Castle L, Scotter MJ, Massey RC, & Springall C (2001) A biomarker approach to measuring human dietary exposure to certain phthalate diesters. *Food Addit Contam*, 18:1068-74.
- BIBRA (1989) Toxicity profile of diisooctyl phthalate. Sutton, UK, British Industrial Biological Research Association.
- Biodynamics Inc (1981) Acute dermal toxicity study in rabbits (Project No. 6675-81). East Millstone, NJ, Biodynamics Inc., TSCATS Doc 878210432, microfiche 206272.
- ECB (2000) IUCLID Dataset on DIOP. European Commission, European Chemicals Bureau.
- Grasso P (1978) Unpublished report on di-2-ethylhexyl and other phthalate esters: an appraisal of the toxicological data. BP Occupational Health Memorandum No. 25-70-0015.
- ICI Chemicals & Polymers (1958) Toxicological report: Diisooctylphthalate CTL/T/132, 11.3.58. Runcorn, Cheshire, ICI Chemicals and Polymers Limited Runcorn, ICI C&P France SA Chocques.
- ICI Chemicals & Polymers (1965) Union Carbide DataSheet 6.11.65 cited in RTECS, DataStar subfile 8.10.93.
- Ikeda GJ, Sapienza PP, Couvillion JL, Farber TM, Smith CP, Inskeep PB, Marks EM, Cerra FE, & Van Loon EJ (1978) Distribution and excretion of two phthalate esters in rats, dogs and miniature pigs. *Fd Cosmet Toxicol*, 16:409-13.
- Lefaux R (1972) *Les Matieres Platiques dans l'Industrie Alimentaire*, p161.
- Litton Bionetics (1981) Evaluation of [Diisooctyl phthalate] in the in vitro transformation of BALB/C-3T3 cells assay. LBI Project no. 20992. TSCATS Doc 878210226, microfiche 206260. Maryland, Litton Bionetics Inc.
- Milkov LE, Aldyreva MV, Popova TB, Lopukhova KA, Makarenko YL, Malyar LM, & Shakhova TK (1973) Health status of workers exposed to phthalate plasticizers in the manufacture of artificial leather and films based on PVC resins. *Environ Health Perspect*, 3:175-8.
- NICNAS (2007a) Phthalate Hazard Compendium: A summary of physicochemical and human health hazard data for 25 phthalate chemicals. Sydney, National Industrial Chemicals Notification and Assessment Scheme.
- NICNAS (2007b) DnOP Hazard Assessment Report. Sydney, National Industrial Chemicals Notification and Assessment Scheme.
- Nishihara T, Nishikawa J, Kanayama T, Dakeyama F, Saito K, Imagawa M, Takatori S, Kitagawa Y, Hori S & Utsumi H (2000). Estrogenic activities of 517 chemicals by yeast two-hybrid assay. *Journal of Health Science* 46 (4), 282-298.
- OECD (2004) SIDS Initial Assessment Report for SIAM 19: Category – High Molecular Weight Phthalate Esters. Organisation for Economic Cooperation and Development, Berlin, Germany, 19-22 October 2004.
- Phthalate Esters Panel HPV Testing Group (2001) High production volume (HPV) chemical challenge programme test plan for the phthalate esters category. December 10, 2001.
- Shibko SI & Blumenthal H (1973) Toxicology of phthalic acid esters used in food-packaging material. *Environ Health Perspect*, 3:131-7.

Tatsuno T (1975) Japan Plastics Age, 13:19.

USS Chemical (year not stated) Mutagenicity evaluation of diisooctyl phthalate. Report no 81-4-7. Goodyear Fiber and Polymer Products Research Division Laboratory, USS Chemicals. EPA doc 878210226.

WR Grace & Co. (1948) Technical brochure: dioctyl phthalate.