4-VINYLCYCLOHEXENE

This substance was considered by previous Working Groups, in February 1976 (IARC, 1976) and in June 1985 (IARC, 1986). Since that time, new data have become available, and these have been incorporated into the monograph and taken into consideration in the present evaluation.

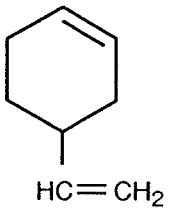
1. Exposure Data

1.1 Chemical and physical data

1.1.1 *Nomenclature*

Chem. Abstr. Serv. Reg. No.: 100-40-3
Chem. Abstr. Name: 4-Ethenylcyclohexene
IUPAC Systematic Name: 4-Vinylcyclohexene
Synonyms: 1-Vinyl-3-cyclohexene; 4-vinyl-1-cyclohexene

1.1.2 *Structural and molecular formulae and relative molecular mass*



C_8H_{12} Relative molecular mass: 108.18

1.1.3 *Chemical and physical properties of the pure substance*

(*a*) *Description*: Colourless liquid (US National Toxicology Program, 1986)
(*b*) *Boiling-point*: 128.9 °C (Lide, 1991)
(*c*) *Freezing-point*: –108.9 °C (Lewis, 1993)
(*d*) *Density*: 0.8299 at 20 °C/4 °C (Lide, 1991)
(*e*) *Spectroscopy data*: Infrared [6321], ultraviolet, nuclear magnetic resonance and mass spectral data have been reported (US National Toxicology Program, 1986; Sadtler Research Laboratories, 1991; US National Library of Medicine, 1993).
(*f*) *Solubility*: Soluble in benzene, diethyl ether and petroleum ether (Lide, 1991); slightly soluble in water (50 mg/L) (DuPont Chemicals, undated)

(*g*) *Volatility*: Vapour pressure, 15 mm Hg [2 kPa] at 25 °C (DuPont Chemicals, 1992); relative vapour density (air = 1), 3.76 (US National Library of Medicine, 1993)

(*h*) *Stability*: Flash-point, 21.2 °C (open cup); temperatures above 26.6 °C and prolonged exposure to oxygen lead to discolouration and gum formation (Lewis, 1993)

(*i*) *Conversion factor*: $mg/m^3 = 4.42 \times ppm$[a]

1.1.4 *Technical products and impurities*

4-Vinylcyclohexene is available as a commercial product with the following specifications: purity, 97 wt% min.; 1,5-cyclooctadiene, 3 wt% max.; water, 200 ppm max.; and *tert*-butylcatechol (inhibitor), 25–200 ppm (DuPont Chemicals, undated). It is also available in research quantities at a purity of 97–99%, inhibited with 50 ppm *para-tert*-butylcatechol (Aldrich Chemical Co., 1992). Trace quantities of 1,5,9-cyclododecatriene and 1,2-divinylcyclobutane have been detected in commercial 4-vinylcyclohexene (Miller, 1978). The commercial product, a dimer of 1,3-butadiene, is not considered to contain significant quantities of 1,3-butadiene.

1.1.5 *Analysis*

4-Vinylcyclohexene can be monitored in workplace air by gas chromatography with flame ionization detection at levels down to 1 ppm (4.4 mg/m^3) (Bianchi & Muccioli, 1981). Low levels were detected by collecting large volumes of air (120 L) on multiple charcoal tubes, desorbing with trichlorofluoromethane and analysing by gas chromatography–mass spectrometry (Cocheo *et al.*, 1983).

4-Vinylcyclohexene has been determined by gas chromatography–mass spectrometry in polymer products after extraction with dimethylformamide and in food after extraction with hexane (Tan *et al.*, 1989).

1.2 Production and use

1.2.1 *Production*

4-Vinylcyclohexene is isolated as a by-product of other production processes involving 1,3-butadiene (see IARC, 1992), including the production of vinylnorbornene, dodecanedioic acid and 1,3-butadiene itself. The 4-vinylcyclohexene isolated in these processes may be sold or converted to the diepoxide, or may be recycled for further use within the production facility (Chemical Manufacturers Association, 1991).

4-Vinylcyclohexene is prepared commercially by catalytic dimerization of 1,3-butadiene at 110–425 °C and 1.3–100 MPa. The catalysts used are typically silicon carbide and copper or chromium salts (Kirshenbaum, 1978).

No data were available to the Working Group on production volume.

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[a]Calculated from: mg/m^3 = (relative molecular mass/24.45) × ppm, assuming normal temperature (25 °C) and pressure (101.3 kPa)

1.2.2 *Use*

4-Vinylcyclohexene has been used as an intermediate for producing flame retardants, flavours and fragrances; in the manufacture of polyolefins; as a solvent; and in the manufacture of special chemicals such as the diepoxide (see monograph, p. 361) (DuPont Chemicals, undated).

1.3 Occurrence

1.3.1 *Natural occurrence*

4-Vinylcyclohexene is not known to occur as a natural product.

1.3.2 *Occupational exposure*

Industrial settings in which workers are potentially exposed include the production of 1,3-butadiene, 4-vinylcyclohexene and 4-vinylcyclohexene diepoxide; production of butadiene-based rubber; rubber vulcanization in the manufacture of shoe soles, tyres and other rubber products; extrusion of electrical cable insulation; flame retardant manufacture; insecticide manufacture; and plasticizer manufacture (Chemical Manufacturers Association, 1991; US National Library of Medicine, 1993). The use of closed vessels in the manufacture and use of 4-vinylcyclohexene in chemical processes limits potential exposure, except for accidental spills and leaks.

Short-term (30-min) area samples taken in three factories of the Italian rubber manufacturing industry contained 0.03–0.21 mg/m^3 in the vulcanization area of a shoe-sole factory, 0–0.003 mg/m^3 in the extrusion area of a tyre retreading factory and 0–0.01 mg/m^3 in the extrusion area of an electrical cable insulation plant (Cocheo *et al.*, 1983). In the USA, the air concentrations of 4-vinylcyclohexene in a tyre curing room ranged from 54.4 to 97.7 ppb (0.24–0.43 mg/m^3) (Rappaport & Fraser, 1977).

Full-shift time-weighted average air concentrations of 4-vinylcyclohexene measured in various US industrial sectors are summarized in Table 1. The highest levels were found during vinylnorbornene production (< 0.04–5.3 mg/m^3) for supervisors, process operators and maintenance workers and during styrene–butadiene/polybutadiene rubber production (< 0.01–5.3 mg/m^3) for polymerization process operators, maintenance workers and supervisors.

1.4 Regulations and guidelines

The American Conference of Governmental Industrial Hygienists (1991, 1992, 1993a,b and Anon., 1991) proposed an 8-h time-weighted average threshold limit value for 4-vinylcyclohexene of 0.4 mg/m^3 in 1990 and established that level in 1992. They also classified 4-vinylcyclohexene as a suspected human carcinogen (A2).

2. Studies of Cancer in Humans

No data were available to the Working Group.

Table 1. Air concentrations of 4-vinylcyclohexene in personal samples taken in various industries in the USA

Industry	Operation/process	No. of samples	Air concentration (range; mg/m^3)
Vinylnorbornene production	Process operator	59	[< 0.04–5.3]
	Waste treatment	21	[< 0.04–0.58]
	Supervisor	2	[4.4]
	Maintenance	12	[0.18–4.9]
Epoxidation	Process operator	10	[0.36–0.4]
	Laboratory technician	5	[0.35]
	Maintenance	4	[≤ 0.04]
Butadiene production	Various	110	[< 0.18]
Styrene–butadiene and polybutadiene rubber production	Polymer operator	110	< 0.01–5.1
	Recovery operator	49	< 0.01–0.7
	Finishing operator	41	< 0.01–0.4
	Laboratory technician	75	< 0.01–1.9
	Maintenance	89	< 0.01–3.0
	Waste treatment	16	< 0.01–0.6
	Supervisor	21	< 0.01–5.3
	Tank farm generator	10	< 0.01–0.09
Tyre manufacture	Tyre building	12	< 0.01–0.07
	Tyre curing	12	< 0.01–0.07

From Chemical Manufacturers Association (1991); year of measurement unspecified

3. Studies of Cancer in Experimental Animals

3.1 Oral administration

3.1.1 *Mouse*

Groups of 50 male and 50 female B6C3F1 mice, eight weeks old, were administered 0 (control), 200 or 400 mg/kg bw 4-vinylcyclohexene (purity, > 98%; impurities in two lots of test chemical included 0.01% butylated hydroxytoluene in one and 0.005% *tert*-butylcatechol in the other, which had been added as inhibitors of peroxide formation) in corn oil by gastric intubation on five days per week for 103 weeks. Body weights and survival were decreased in both males (control, 37/50; low-dose, 39/50; high-dose, 7/50) and females (40/50, 39/50, 17/50, respectively) in the high-dose groups. Female mice showed a significant treatment-related increase in the incidence of granulosa-cell tumours of the ovary (control, 1/49; low-dose, 10/48; high-dose 13/47) and of mixed tumours composed of epithelial and granulosa cells (0/49, 25/48, 11/47, respectively) of the ovary ($p < 0.001$; incidental tumour trend test). The incidences of granulosa-cell hyperplasia and tubular-cell hyperplasia of the ovary were also increased in treated females. There was a significantly ($p = 0.027$; incidental tumour trend test) increased incidence of adrenal subcapsular adenoma in treated female mice (control, 0/50; low-dose, 3/49; high-dose, 4/48). After adjustment for mortality, the incidences of lymphoma (control, 4/50; low-dose, 7/50; high-dose, 5/50; $p = 0.01$; incidental

tumour trend test; $p = 0.001$ incidental pair-wise test for high dose *versus* control) and of alveolar–bronchiolar adenoma or carcinoma (control, 4/49; low-dose, 11/50; high-dose, 4/50; $p = 0.047$; incidental tumour trend test) were slightly increased in treated males (US National Toxicology Program, 1986; Collins *et al.*, 1987).

3.1.2 *Rat*

Groups of 50 male and 50 female Fischer 344/N rats, seven weeks old, were administered 0 (control), 200 or 400 mg/kg bw 4-vinylcyclohexene (purity, as above) in corn oil by gastric intubation on five days per week for 103 weeks. Body weights were reduced in males given the high dose, and survival was reduced in treated males (control, 33/50; low-dose, 13/50; high-dose, 5/50) and females (40/50, 28/50, 13/50, respectively). The incidence of squamous-cell papilloma or carcinoma of the skin was increased in high-dose males (control, 0/50; low-dose, 1/50; high-dose, 4/50; $p = 0.001$, life table pair-wise comparison of high-dose with controls). The incidence of clitoral gland adenoma or squamous-cell carcinoma was increased in low-dose females (control, 1/50; low-dose, 5/50; high-dose, 0/49; $p = 0.04$, incidental tumour test, pairwise comparison of low-dose with controls) (US National Toxicology Program, 1986; Collins *et al.*, 1987). [The Working Group noted the poor survival.]

3.2 Skin application

Mouse: A group of 30 male Swiss ICR/HA mice, eight weeks old, received skin applications of 45 mg 4-vinylcyclohexene (purified by removing autooxidation products with ferrous sulfate) in 0.1 ml of a 50% solution of benzene three times per week for life (approximately 100 mg of solution per application). The median survival time was 375 days. Five squamous-cell papillomas and one squamous-cell carcinoma of the skin occurred, while the incidence of skin tumours in a control group of 150 mice treated with benzene was 10 papillomas and one carcinoma [$p = 0.04$, Fisher's exact test] (Van Duuren *et al.*, 1963). [The Working Group noted the carcinogenic potential of the vehicle.]

A group of 30 male Swiss ICR/HA mice [age unspecified] received skin applications of 9 mg 4-vinylcyclohexene [purity not specified but stated to be 'oxygen-free'] in 0.1 ml of a 50% solution of benzene, three times a week for life. The median survival was 565 days; no skin tumour occurred (Van Duuren, 1965). [The Working Group noted the low dose used.]

3.3 Carcinogenicity of metabolites

See the monograph on 4-vinylcyclohexene diepoxide.

4. Other Data Relevant for an Evaluation of Carcinogenicity and Its Mechanisms

4.1 Absorption, distribution, metabolism and excretion

4.1.1 *Humans*

No data were available to the Working Group.

4.1.2 *Experimental systems*

A single dose of 400 mg/kg bw ^{14}C-4-vinylcyclohexene given by oral gavage in corn oil to fasted female B6C3F1 mice and Fischer 344 rats resulted in peak blood levels of about 100 nmol/ml between 1 and 2 h after administration. Mice eliminated 95% of the radioactivity within 24 h, whereas rats required 48 h. The main routes of excretion of the radioactivity were the urine (50–60%) and expired air (30–40%). The concentration of 4-vinylcyclohexene was highest in adipose tissue (about 5 μmol/g), which was about 10 times higher than that in tissues such as liver, skin and ovary (Smith *et al.*, 1990a).

4-Vinylcyclohexene is metabolized mainly to 4-vinyl-1,2-epoxycyclohexane. A peak blood level of 41 nmol/ml of the epoxide was detected 1–2 h after intraperitoneal injection of 800 mg/kg 4-vinylcyclohexene in female mice. In female Fischer 344 rats, the epoxide blood level was never above the limit of detection of 2.5 nmol/ml. 4-Epoxyethylcyclohexene was not detected in the blood of either species at the same limit of detection (Smith *et al.*, 1990a).

Microsomal mixed-function oxidases from the livers of Wistar rats and Swiss mice metabolize 4-vinylcyclohexene (1; see Fig. 1) to 4-vinyl-1,2-epoxycyclohexane (2), 4-epoxyethylcyclohexene (3) and traces of 4-epoxyethyl-1,2-epoxycyclohexane (4-vinylcyclohexene diepoxide) (4) (see monograph, p. 361). These epoxides are further hydrolysed by epoxide hydrolase to the corresponding diols: 4-vinylcyclohexane-1,2-diol (5), 4-dihydroxyethylcyclohexene (6) and possibly 4-epoxyethylcyclohexane-1,2-diol (7). The last two metabolites may be further metabolized to 4-dihydroxyethyl-1,2-epoxycyclohexane (8) and the tetrol 4-dihydroxyethylcyclohexane-1,2-diol (Gervasi *et al.*, 1981; Watabe *et al.*, 1981).

4.1.3 *Comparison of humans and animals*

Liver microsomes from B6C3F1 mice formed 4-vinyl-1,2-epoxycyclohexane 13 times faster than microsomes from humans and six times faster than those from Fischer 344 rats. The rate of 4-vinylcyclohexene epoxidation by hepatic microsomes derived from men and women was similar. The rate of formation of 4-epoxyethylcyclohexene was about six times lower than that of 4-vinyl-1,2-epoxycyclohexane in humans (Smith & Sipes, 1991).

4.2 Toxic effects

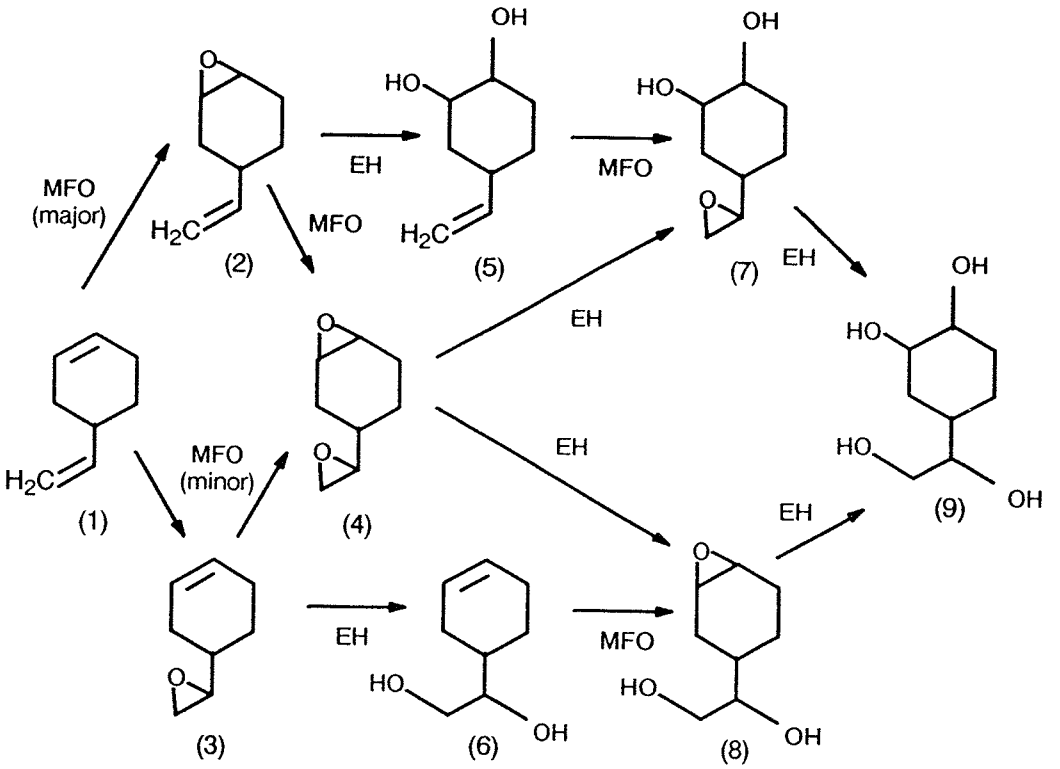
4.2.1 *Humans*

No data were available to the Working Group.

4.2.2 *Experimental systems*

B6C3F1 mice were administered 0, 75, 150, 300, 600 or 1200 mg/kg bw 4-vinylcyclohexene and Fischer 344 rats 0, 50, 100, 200, 400 or 800 mg/kg bw, daily by oral gavage in corn oil on five days per week for 13 weeks. Extensive mortality was observed in the mice treated with 1200 mg/kg, and the final body weights of male rats administered $\geq$ 400 mg/kg, of female rats administered 800 mg/kg and of female mice receiving 600 mg/kg were reduced. Compound-related histopathological effects included hyaline droplet degeneration of the proximal convoluted tubules of the kidney in treated male rats and a reduction in the number

Fig. 1. Possible pathways for the metabolism of 4-vinylcyclohexene by hepatic microsomes



From Gervasi *et al.* (1981); EH, epoxide hydrolase; MFO, mixed-function oxidases
(1) 4-Vinylcyclohexene; (2) 4-vinyl-1,2-epoxycyclohexane; (3) 4-epoxyethylcyclohexene; (4) 4-epoxyethyl-1,2-epoxycyclohexane (4-vinylcyclohexene diepoxide); (5) 4-vinylcyclohexane-1,2-diol; (6) 4-dihydroxyethylcyclohexene; (7) 4-epoxyethylcyclohexane-1,2-diol; (8) 4-dihydroxyethyl-1,2-epoxycyclohexane; (9) 4-dihydroxyethylcyclohexane-1,2-diol

of primary follicles and mature graafian follicles in the ovaries of female mice receiving 1200 mg/kg. No compound-related gross or histopathological effect was evident in treated female rats or in male mice in the 13-week study (Collins & Manus, 1987).

4-Vinylcyclohexene and its epoxides were compared with respect to the dose required to reduce the number of oocytes to 50% that of controls (ED_{50}). After intraperitoneal injection to female B6C3F1 mice, the ED_{50} doses were 2.7 mmol/kg bw for 4-vinylcyclohexene, 0.5 mmol/kg bw for 4-vinyl-1,2-epoxycyclohexane, 0.7 mmol/kg bw for 4-epoxyethylcyclohexene and 0.2 mmol/kg bw for 4-vinylcyclohexene diepoxide. In female Fischer 344 rats, the ED_{50} dose was > 7.4 mmol/kg bw for 4-vinylcyclohexene, 1.4 mmol/kg bw for the 1,2-epoxide and 0.4 mmol/kg bw for the diepoxide (Smith *et al.*, 1990b).

4-Vinylcyclohexene was administered on five days a week by oral gavage to Fischer 344 rats and B6C3F1 mice in a 90-day toxicity study and in a two-year carcinogenicity study at 200 and 400 mg/kg bw (US National Toxicology Program, 1986). In the 90-day study, ovarian atrophy was seen in female mice but no significant microscopic lesions were seen in rats. After two years of exposure, 4-vinylcyclohexene produced ovarian hyperplasia and neoplasia

in mice but not in rats. The findings were interpreted as indicating a relationship between previous ovarian toxicity and subsequent ovarian neoplasia (Maronpot, 1987).

As reported in an abstract, DeMerell *et al.* (1992) treated groups of eight male B6C3F1 mice with 0 or 800 mg/kg bw 4-vinylcyclohexene intraperitoneally daily for 30 days and killed them one day later. There was no effect on testicular weight or histological appearance or on plasma follicle-stimulating hormone level. Similarly, the reduction in small and growing follicles induced by administration of 650 mg/kg bw [6.0 mmol/kg] 4-vinylcyclohexene per day intraperitoneally for 30 days to groups of 15 B6C3F1 mice was not accompanied by any change in plasma follicle-stimulating hormone levels (Hooser *et al.*, 1993).

4.3 Reproductive and prenatal effects

4.3.1 *Humans*

No data were available to the Working Group.

4.3.2 *Experimental systems*

Grizzle *et al.* (1994) treated Swiss CD-1 mice with 4-vinylcyclohexene in corn oil at 0 (40 males and 40 females), 100, 250 or 500 mg/kg bw (20 males and 20 females in each treatment group) orally by gavage daily in a continuous breeding study for 14 weeks of cohabitation. No effect was observed on number of litters, pups per litter or percentage born alive. The progeny of the control and 500-mg/kg groups were then mated and their respective treatments continued without a break. No adverse effects of treatment on reproductive performance were observed. In the F1 males treated with 500 mg/kg bw, testicular spermatid count was decreased by 17%, with no effect on epididymal sperm number or testicular weight. In the treated F1 females, there were significantly reduced numbers of primordial (33%), growing (55%) and antral (33%) oocytes. Ovarian weight and oestrus cycles were unaffected.

4.4 Genetic and related effects (see also Table 2 and Appendices 1 and 2)

4.4.1 *Humans*

No data were available to the Working Group.

4.4.2 *Experimental systems*

4-Vinylcyclohexene was not mutagenic to *Salmonella typhimurium*.

4-Vinylcyclohexene diepoxide and its metabolites are described in a separate monograph. The two mono-epoxides, 4-vinyl-1,2-epoxycyclohexane and 4-epoxyethylcyclohexene were not mutagenic to *S. typhimurium* in the absence of an exogenous metabolic system. 4-Vinyl-1,2-epoxycyclohexane was also not mutagenic to cultured Chinese hamster lung V79 cells at the *hprt* locus, but did cause micronuclei and aberrant anaphases in these cells.

Table 2. Genetic and related effects of 4-vinylcyclohexene and its metabolites

Test system	Result[a]		Dose[b] (LED/HID)	Reference
	Without exogenous metabolic system	With exogenous metabolic system		
SA0, *Salmonella typhimurium* TA100, reverse mutation	–	–	500.0000	Zeiger *et al.* (1987)
SA5, *Salmonella typhimurium* TA1535, reverse mutation	–	–	500.0000	Zeiger *et al.* (1987)
SA7, *Salmonella typhimurium* TA1537, reverse mutation	–	–	500.0000	Zeiger *et al.* (1987)
SA9, *Salmonella typhimurium* TA98, reverse mutation	–	–	500.0000	Zeiger *et al.* (1987)
4-Vinyl-1,2-epoxycyclohexane				
SA0, *Salmonella typhimurium* TA100, reverse mutation	–	0	620.0000	Watabe *et al.* (1980)
SA0, *Salmonella typhimurium* TA100, reverse mutation	–	0	400.0000[c]	Turchi *et al.* (1981)
SA5, *Salmonella typhimurium* TA1535, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA7, *Salmonella typhimurium* TA1537, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA8, *Salmonella typhimurium* TA1538, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA9, *Salmonella typhimurium* TA98, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
G9H, Gene mutation, Chinese hamster lung V79 cells, *hprt* locus	–	0	2500.0000	Turchi *et al.* (1981)
MIA, Micronucleus formation[d], Chinese hamster lung V79 cells	+	0	300.0000	Turchi *et al.* (1981)
4-Epoxyethylcyclohexene				
SA0, *Salmonella typhimurium* TA100, reverse mutation	–	0	620.0000	Watabe *et al.* (1980)
SA5, *Salmonella typhimurium* TA1535, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA7, *Salmonella typhimurium* TA1537, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA8, *Salmonella typhimurium* TA1538, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)
SA9, *Salmonella typhimurium* TA98, reverse mutation	–	0	1200.0000	Watabe *et al.* (1980)

[a] +, positive; (+), weakly positive; –, negative; 0, not tested; ?, inconclusive (variable responses in several experiments within an adequate study)

[b] In-vitro tests, μg/ml; in-vivo tests, mg/kg bw

[c] Overnight incubation with bacteria before plating, 0.1 ml sample, but also negative in standard test

[d] Aberrant anaphases were observed at the same dose.

5. Summary of Data Reported and Evaluation

5.1 Exposure data

4-Vinylcyclohexene is produced by catalytic dimerization of 1,3-butadiene. 4-Vinylcyclohexene has been used as a chemical intermediate for production of flame retardants, flavours and fragrances, in the manufacture of polyolefins, as a solvent and in the manufacture of its diepoxide. Low levels of occupational exposure have been measured during the production and use of 1,3-butadiene.

5.2 Human carcinogenicity data

No data were available to the Working Group.

5.3 Animal carcinogenicity data

4-Vinylcyclohexene was tested for carcinogenicity in one experiment in mice and in one experiment in rats by gastric intubation and in two skin application studies in mice. Administration of 4-vinylcyclohexene by gastric intubation produced granulosa-cell and mixed tumours of the ovary and adrenal subcapsular tumours in female mice. In male mice, there was an increase in the incidence of lymphoma and of lung tumours. Following gastric intubation in rats, increased incidences of squamous-cell tumours of the skin in males and of clitoral gland tumours in females were observed. The studies by skin application were inadequate for evaluation.

5.4 Other relevant data

4-Vinylcyclohexene is distributed mainly to adipose tissue in rodents. The ethylene carbons are eliminated mainly in urine and expired air. Metabolism primarily involves oxidation to 4-vinylcyclohexane-1,2-epoxide, which is formed 13 times faster by liver microsomes from mice and twice as fast by those from rats than by human microsomes. 4-Vinyl-1,2-epoxycyclohexane, 4-epoxyethylcyclohexene and, particularly, the diepoxide are more toxic to mouse oocytes than 4-vinylcyclohexene itself. Treatment with 4-vinylcyclohexene decreased the number of oocytes in mice but not in rats. The difference seemed to be due to the reduced ability of the rat to metabolize 4-vinylcyclohexene to epoxides.

No data were available on the genetic and related effects of 4-vinylcyclohexene in humans.

4-Vinylcyclohexene and its mono-epoxide metabolites were not mutagenic to *Salmonella typhimurium*. 4-Vinyl-1,2-epoxycyclohexane induced micronuclei but not *hprt* mutations in cultured Chinese hamster cells.

5.5 Evaluation[1]

There is *inadequate evidence* in humans for the carcinogenicity of 4-vinylcyclohexene.

There is *sufficient evidence* in experimental animals for the carcinogenicity of 4-vinylcyclohexene.

Overall evaluation

4-Vinylcyclohexene *is possibly carcinogenic to humans (Group 2B).*

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[1]For definition of the italicized terms, see Preamble, pp. 27–30.

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