

XII. TABLES

TABLE XII-1

PHYSICAL PROPERTIES OF 1,1,1-TRICHLOROETHANE

Chemical Abstract's serial number	000071556		
Synonyms	1,1,1-Trichloroethane Methyl chloroform Alpha-trichloroethane		
Molecular formula	CH ₃ CCl ₃		
Formula weight	133.41		
Boiling point	74.0 C (165.2 F) (760 mm Hg)		
Melting point	-32.62 C (-26.7 F)		
Vapor density	4.6 (air = 1)		
Specific gravity	1.339 (20 C), (water = 1.000 at 4 C)		
Solubility	0.44g/100g water at 25 C; soluble in ethyl ether, ethyl alcohol		
Density of saturated air	1.6 (air = 1)		
Concentration of saturated air	16.7% by volume at 25 C		
Flammable (explosive) limits	10-15% in air with hot wire ignition		
Flash point	None		
Autoignition temperature	500 C (932 F)		
Vapor pressure	Temp F	Temp C	mm Hg
	50	10	62
	68	20	100
	77	25	127
	86	30	150
	104	40	240

TABLE XII-1 (CONTINUED)

PHYSICAL PROPERTIES OF 1,1,1-TRICHLOROETHANE

Conversion factors, 1 mg/liter = 1 g/cu m = 183 ppm
(25C 760 mm Hg) 1 ppm = 5.46 mg/cu m = 5.46 μ g/liter

Adapted from references 1,5,6,8,12-15

TABLE XII-2

CONCENTRATIONS OF 1,1,1-TRICHLOROETHANE
IN BLOOD OF EXPOSED SUBJECTS

	Arterial Blood, ppm		Venous Blood, ppm		No. of Subjects
	Mean	SD	Mean	SD	
250 ppm					
rest 36.5 ft-lbs/sec	3.0	± 0.2	1.4	± 0.2	12
exercise,	4.5	± 0.2	3.1	± 0.4	9
73.0 ft-lbs/sec	5.2	± 0.1	3.5	± 0.8	4
exercise					
109.5 ft-lbs/sec	5.5	± 0.3	4.4	± 0.4	4
350 ppm					
rest	5.0	± 0.5	3.0	± 0.6	5
exercise					
36.5 ft-lbs/sec	7.2	± 0.4	4.0	± 6.6	5
250 ppm					
rest	1.9 - 2.5*		0.5 - 1.2*		3
rest + 4% CO ₂	3.0 - 3.9*		0.9 - 1.3*		3
exercise + 4% CO ₂	3.2 - 4.5*		1.4 - 2.3*		3

* Range is presented by authors when n<3.
Adapted from Astrand et al [54]

TABLE XII-3

EFFECTS OF 1,1,1-TRICHLOROETHANE EXPOSURE* AT 875 ppm
ON REPRODUCTION DATA OF RATS AND MICE

	Rats		Mice	
	Control	Exposed	Control	Exposed
Number of litters	30	23	26	13
Corpora lutea/dam	15 ± 2	14 ± 2	--	--
Implantation sites/ litter	13 ± 2	11 ± 4	14 ± 2	14 ± 2
Live fetuses/litter	12 ± 3	10 ± 4	12 ± 2	12 ± 2
%, resorptions/ implantation sites	4 (16/378)	7 (19/255)	10 (39/369)	8 (14/175)
%, litters with resorptions	40 (12/30)	56 (13/23)	69 (18/26)	77 (10/13)
Litters totally resorbed	0/30	0/23	0/26	1/13
Resorptions/litters with resorptions	1.3 (16/12)	1.5 (19/13)	2.2 (39/18)	4.3 (26/6)
Sex ratio, M:F	54:46	53:47	54:46	47:53
Fetal body weight, g	5.42 ± 0.45	5.86 ± 0.32	1.30 ± 0.08	1.27 ± 0.13
Fetal crown-rump length, mm	43.5 ± 1.4	44.0 ± 0.7	26.2 ± 0.8	25.6 ± 1.0

* Also includes 50 ppm impurities and inhibitors
Adapted from Schwetz et al [103]

TABLE XII-4

FETAL ANOMALIES FOUND IN MICE AFTER MATERNAL
EXPOSURE TO 1,1,1-TRICHLOROETHANE AT 875 ppm

Anomalies	Control % No.	Exposed % No.
GROSS		
Short tail	(0)	8 (1)
Runts (wt. less than means X - 3 S.D.)	38 (10)	31 (4)
SOFT TISSUE		
Cleft palate	(0)	8 (1)
Subcutaneous edema	27 (7)	38 (5)
SKELETAL		
Delayed ossification - skull bones	69 (18)	62 (8)
Lumbar ribs or spurs	31 (8)	38 (5)
Delayed ossification - sternebrae	4 (1)	23 (3)
Split sternebrae	(0)	15 (2)
Extra sternebrae	(0)	8 (1)
Malaligned sternebrae	(0)	15 (2)
Number of litters examined	26	13

Adapted from Schwetz et al [103]

TABLE XII-5

FETAL ANOMALIES FOUND IN RATS AFTER MATERNAL
EXPOSURE TO 1,1,1-TRICHLOROETHANE AT 875 ppm

	<u>Control</u>		<u>Exposed</u>	
	%	No.	%	No.
SOFT TISSUE				
Dilated renal pelvis		(0)	4	(1)
Subcutaneous edema	17	(5)	17	(4)
SKELETAL				
Delayed ossification - skull bones	33	(10)	30	(7)
Lumbar ribs or spurs	13	(4)	22	(5)
Delayed ossification - sternebrae	30	(9)	16	(3)
Split sternebrae		(0)	4	(1)
Supernumerary vertebra (one, thoracic)		(0)	4	(2)
Number of litters examined		30		23

Adapted from Schwetz et al [103]

TABLE XII-6

INHALATION EXPOSURES AND EFFECTS IN HUMANS

Reference	Exposure Data	Effects
Dornette and Jones [33]	10,000-26,000 ppm 6,000-22,500 ppm	Induction of anesthesia usually within 2 minutes Maintenance of anesthesia ECG changes
Kleinfeld and Feiner [48]	More than 5,000 ppm 10 minutes	Occupational fatality
Siebecker et al [34]	Anesthesia	Circulatory depression before EEG changes
Stewart et al [35]	0-2,650 ppm 15 minutes	2 of 7 exposed subjects unable to stand; feeling of malaise for 5 hours; positive urinary urobilinogen
Torkelson et al [36]	1,740-2,180 ppm 1,000 ppm 70-75 minutes	Disturbed equilibrium Positive Romberg test ECG's normal Impaired coordination and equilibrium
Stewart et al [35]	900-950 ppm 20-73 minutes	Impaired Romberg tests, elevated urinary urobilinogen
Torkelson et al [36]	500 ppm 450 minutes	Reflexes, equilibrium, blood pressure, and pulse rate not disturbed
Stewart et al [39]	500 ppm 7 hours/day 5 days	Mild sleepiness; light-headedness; headache; impaired Romberg tests; eye nose and throat irritation; no evidence of liver or kidney injury
Stewart et al [35]	500 ppm 3 hours	Balance and coordination not affected

TABLE XII-6 (CONTINUED)
 INHALATION EXPOSURES AND EFFECTS IN HUMANS

Reference	Exposure	Species and Effects
Salvini et al [37]	450 ppm 8 hours	Decreased perceptive capabilities under stress conditions; eye, nose and throat irritation
Gamberale and Hultengren [38]	350 ppm 2 hours	Perceptual speed, reaction times, and manual dexterity impaired
	250 ppm 2 hours	Perceptual speed, reaction times, and manual dexterity not impaired
Binaschi [63]	250 ppm Occupational	Unspecified symptoms
Kramer et al [64]	115 ppm Occupational	No significant disturbances of hematology or blood chemistry
Weitbrecht [61]	Occupational exposure with skin exposure several months	Conjunctival and respiratory irritation; headache; tiredness; insomnia; gastrointestinal complaints; positive urobilinogen; autonomic and circulatory dystrophy; psychasthenia

TABLE XII-7

INHALATION EXPOSURES AND CENTRAL NERVOUS
SYSTEM EFFECTS IN ANIMALS

Reference	Exposure	Species and Effects
Adams et al [73]	18,000 ppm, 5 minutes	Rats, helpless
	3 hours	Rats, unconscious
	14,250 ppm, 3 hours	Rats, LC50
	7 hours	Rats, LC50
Truhaut et al [75]	16,850 ppm, 5 minutes	Rabbits, increased EEG activity
	More than 5 minutes	Decreased EEG activity
Gehring [70]	13,500 ppm, 16 minutes	Mice, anesthesia
Adams et al [73]	10,000 ppm, 1-2 minutes	Rats, decreased activity
	10 minutes	Rats, helpless
	3 hours	Rats, semiconscious
Truhaut et al [76]	6,250 ppm, 1 hour	Rabbits, sustained increase in EEG activity
Adams et al [73]	5,000 ppm, 1 hour	Rats, mild narcotic effect
	1 hour	Monkey, slight ataxia
	5 hours	Monkey, trembling of hands and forearms
Horiguchi and Horiuchi [74]	1,000 ppm, 2 hours/day 9 exposures on alternate days	Mice, increased running activity
Tsapko and Rappoport [77]	180-900 ppm, 4 hours	Rats and cats, threshold for altering conditioned reflex activity
	73 ppm, 4 hours/day up to 120 days	Cats, differentiation reflexes deranged
	50 days	
	120 days	Rats, more extreme pathologic changes in nervous tissue

TABLE XII-8

INHALATION EXPOSURES AND CARDIOVASCULAR
EFFECTS IN ANIMALS

Reference	Exposure	Species and Effects
Griffiths et al [46]	125,000 ppm 1.5-6 minutes	Dogs, abrupt drop in blood pressure; ventricular fibrillation in 1 dog on second exposure; gross congestion in all tissues; heart cell necrosis
Belej et al [79]	25,000 ppm, 5 minutes	Rhesus monkeys, cardiac arrhythmias; myocardial depression; tachycardia
Herd et al [80]	8,000 ppm, 5 minutes	Dogs, sharp decrease in peripheral resistance followed by decreased stroke volume, heart rate and myocardial- contractility
Truhaut et al [75]	6,250 ppm, 10 minutes	Rabbits, cardiovascular depression
Reinhardt et al [81]	5,000 ppm, 5 minutes 2,500 ppm, 5 minutes	Dogs, cardiac sensitization to epinephrine Dogs, no cardiac sensitization to epinephrine
Tsapko and Rappoport [77]	73 ppm, 4 hours/day 50 days 120 days	Rats, venous hyperemia and small foci of swelling in heart muscle, more severe at 120 days

TABLE XII-9

INHALATION EXPOSURES AND PULMONARY EFFECTS IN ANIMALS

Reference	Exposure Data	Species and Effects
Torkelson et al [36]	2,000 ppm, 12 minutes/day 5 days/week 69 exposures	Guinea pigs, lung irritation
	1,000 ppm, 72 minutes/day 5 days/week 69 exposures	Guinea pigs, lung irritation
Horiguchi and Horiuchi [74]	1,000 ppm, 2 hours/day 9 exposures on alternate days	Mice, lung congestion
Prendergast et al [85]	370 ppm, continuously for 90 days	Several species, nonspecific inflammation changes
MacEwan and Vernot [88]	250 ppm, continuously for 90 days	Rats, chronic respiration disease
Prendergast et al [85]	135 ppm, continuous for 90 days	Several species, varying degrees of lung congestion and pneumonitis
Tsapko and Rappoport [77]	73 ppm, 4 hours/day 50 or 120 days	Rats, emphysematous changes; swelling of bronchial membranes; hyperplastic peribronchial lymphatic nodules

TABLE XII-10

INHALATION EXPOSURES AND LIVER AND KIDNEY EFFECTS IN ANIMALS

Reference	Exposure	Species and Effects
Adams et al [73]	18,000 ppm, 2 hours	Rats, increased kidney weights
	12,000 ppm, 7 hours	Rats, increased liver weights, fatty liver changes, congestion and hemorrhagic necrosis; increased kidney weights
	8,000 ppm, 7 hours	Rats, fatty changes in liver
Torkelson et al [36]	10,000 ppm, 1 hour/day 5 days/week/70 times	Rats, increased liver weights and fatty changes
	0.5, 0.2, 0.05 hours/day 5 days/week/70 times	Rats, liver weights not increased
Adams et al [73]	3,000 ppm, 7 hours/day 5 days/week 20 exposures	Guinea pigs, fatty degeneration of the liver; no kidney or liver effects in rats or monkeys
	1,500 ppm, 7 hours/day 5 days/week for 2 mo	Rats and monkeys, no kidney or liver no effects
	650 ppm, 7 hours/day 5 days/week for 3 months	Guinea pigs, no kidney or liver effects
Pendergrast et al [85]	2,200 ppm, 8 hours/day 5 days/week for 6 weeks	Rats, guinea pigs, rabbits, dogs, monkeys, no evidence of kidney or liver injury
Torkelson et al [36]	2,000 ppm, 12 minutes/day, 5 days/week 69 exposures	Guinea pigs, increased liver weights with fatty changes
	2,000 and 1,000 ppm < 0.2 hours/day 69 exposures	Guinea pigs, liver weights not increased

TABLE XII-10 (CONTINUED)

INHALATION EXPOSURES AND LIVER AND KIDNEY EFFECTS IN ANIMALS

Reference	Exposure	Species and Effects
Torkelson et al [36] (continued)	500 ppm, 7 hours/day 5 days/week, 126-130 exposures	Rats, guinea pigs, rabbits, and monkeys, no liver or kidney effects
Horiguchi and Horiuchi [74]	1,000 ppm, 2 hours/day 9 exposures on alternate days	Mice, liver congestion, inflammation around biliary ducts
MacEwen and Vernot [88]	1,000 ppm, continuously for 90 days	Mice, increased liver weights; increased liver triglycerides; focal hepatocyte necrosis; acute inflammatory infiltrate and hypertrophy of Kupffer cells Rats, increased liver weights; vesiculation of the endoplasmic reticulum of hepatocytes with loss of polyribosomes; increased smooth endoplasmic reticulum Monkeys and dogs, no lesions observed.

TABLE XII-10 (CONTINUED)

INHALATION EXPOSURES AND LIVER AND KIDNEY EFFECTS IN ANIMALS

Reference	Exposure	Species and Effects
MacEwen and Vernot [88] continued	250 ppm, continuously for 100 days	Rats, above changes mild to minimal; mice, no change in liver weight nor in triglycerides; monkeys and dogs, no lesions observed
Prendergrast et al [85]	135 ppm, continuously for 90 days	Rats, guinea pigs, rabbits, dogs, monkeys, no evidence of liver or kidney injury
McNutt et al [41]	1000 ppm, continuously for 14 weeks	Mice, significant changes in centrilobular hepatocytes; moderate triglyceride accumulation; necrosis of hepatocytes
	250 ppm, continuously for 14 weeks	Mice, mild to minimal cytoplasmic alterations of centrilobular hepatocytes
Tsapko and Rappoport [77]	73 ppm, 4 hours/day 50 days	Rats, venous hyperemia and swelling of individual groups of cells
	120 days	Rats, above findings exaggerated; protein dystrophy of the liver parenchymal cells

TABLE XII-11

COMPARISON OF THREE ANALYTICAL METHODS
FOR DETERMINING 1,1,1-TRICHLOROETHANE
CONCENTRATIONS

Sampling time, minutes	1,1,1-Trichloroethane, ppm		
	Colorimetry	Gas chromatography	Detector tube
Exp. 1 0	117.5	(90.0)*	175
15	137.5	-	220
30	227.5	140.6	220
45	222.5	-	350
60	192.5	236.3	220
75	165.0	-	280
90	210.0	236.3	250
105	237.5	-	340
120	247.5	162.9	-
Average	195.2	194.0	256.9
Exp. 2 0	277.5	(187.6)*	300
15	297.5	-	500
30	297.5	258.3	350
45	415.0	-	550
60	387.5	302.2	420
75	-	-	300
90	500.0	374.7	650
105	362.5	-	580
120	471.9	320.1	-
Average	376.2	313.8	456.2

TABLE XII-11 (CONTINUED)

COMPARISON OF THREE ANALYTICAL METHODS
FOR DETERMINING 1,1,1-TRICHLOROETHANE
CONCENTRATIONS

Sampling time, minutes	1,1,1-Trichloroethane, ppm		
	Colorimetry	Gas chromatography	Detector tube
Exp. 3 0	485.0	(339.0)*	650
15	445.0	-	580
30	695.0	551.2	650
45	605.0	-	620
60	520.0	495.0	620
75	542.5	-	550
90	662.5	601.1	600
105	605.0	-	790
120	465.0	545.0	-
Average	558.3	548.0	632.5
Exp. 4 0	760.0	(372.3)*	780
15	792.5	-	810
30	830.0	538.7	760
45	870.0	-	730
60	830.0	603.8	800
75	870.0	-	810
90	792.5	619.8	720
105	870.0	-	750
120	870.0	603.8	-
Average	831.6	591.4	770.0

* Numbers in parenthesis are not used in the calculation of the mean
Adapted from Fukabori [55]

TABLE XII-12

1,1,1-TRICHLOROETHANE EXPOSURE CONCENTRATIONS

Type of Operation and Reference	Environmental Level (ppm)	Toxic Effects Reported	Basis for Medical Evaluation	Total No. of Subjects	No. of Subjects Reporting Symptoms
Solvent Testing [146]	407*	Headaches	Medical Interview	12	"some"
Painting [141]	350	Dermatitis**	Medical interview, review of medical records	25	3
Grinding degreasing [146]	350	(Headache, cough, dizziness)**	Medical interview	12	2
Hose braiding [142]	17.5-179	(Respiratory, eye, and neural symptomatology, urticaria)**	Medical interview	19	19
Degreasing [143]	12-118	Dry nose	Physical examination (eye, ear, nose and throat) and medical interview	250	1
Visi-trol [141]	5.5-77	Dermatitis**	Medical interview	25	3

TABLE XII-12 (CONTINUED)
1,1,1-TRICHLOROETHANE EXPOSURE CONCENTRATIONS

Type of Operation and Reference	Environmental Level (ppm)	Toxic Effects Reported	Basis for Medical Evaluation	Total No. of Subjects Interviewed	No. of Subjects Reporting Symptoms
Grease spraying, paint repair [144]	39	No adverse effects	None	40	0
Gasket machine operations [145]	1-31	No adverse effects	Medical interview, urine hippuric acid determinations	13	0
Injection molding [144]	<1	No adverse effects	Medical interview	8	0

* Exposure for several hours daily, not a TWA

** Not attributed to 1,1,1-trichloroethane by author of report

Adapted from NIOSH Health Hazard Evaluation Reports [141-146]

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