INFORMATION PROFILES ON POTENTIAL OCCUPATIONAL HAZARDS

VOLUME II. CHEMICAL CLASSES

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Final Report
Contract No. 210-78-0019

December 1979

Prepared for:

National Institute for Occupational Safety and Health
5600 Fishers Lane
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INTRODUCTION

An information profile is a working paper used by the National Institute for Occupational Safety and Health (NIOSH) to assist in establishing Institute priorities. It is an initial step in determining the need to develop comprehensive documents or to initiate research. Each profile summarizes data on known and suspected health effects, the extent of worker exposure, physical and chemical properties, and the industrial importance of individual chemicals and classes of chemicals. The profile may also be used by industry, labor, and the occupational health community as a synopsis of information on each subject and to identify possible health hazards associated with their workplaces.

Although detailed literature searches are conducted using computerized and manual searching techniques to identify pertinent and recent information, not all the literature obtained is incorporated in the report due to the summary nature of the profiles. Further, literature published after 1978 may not be included in these profiles because it was generally unavailable at the time the search was completed.

ACRYLIC ACID AND ESTERS

SUMMARY

The primary use of acrylic acid is as a production intermediate for various acrylates; acrylates are primarily used to prepare emulsion and solution polymers for use in surface coatings, textiles, and other applications. In 1977, 283 million pounds of acrylic acid were produced, and total acrylate production was nearly 630 million pounds. Yearly occupational exposure to acrylic acid and its esters is in excess of 100,000 workers.

Both ethyl acrylate and methyl acrylate have been found to cause irritation when applied to the skin of rabbits, and fatal doses following acute oral administration interfere with coordination and respiration, and cause degenerative changes in the lungs, kidneys, heart, liver, and spleen. The subchronic oral administration of methyl and ethyl acrylate has not produced any toxic symptoms in rabbits other than small weight losses and growth retardation, but the subchronic inhalation of acrylic acid and 2-ethylhexyl acrylate induced nasal irritation and lethargy as well. Carcinogenic effects from ethyl acrylate have not been observed in an ongoing chronic inhalation experiment with mice and rats. In rats, embryonic-fetal toxicity and teratogenic effects have been induced following the intraperitoneal administration of acrylic acid during gestation.

1. Synonyms

2. Chemical Abstracts Service (CAS) Number

3. Registry of Toxic Effects of Chemical Substances (RTECS) Number

4. Molecular Formula

5. Chemical Structure

6. Physical and Chemical Properties

The above information for acrylic acid and its esters discussed in this profile is listed in Table 1.

7. Producer and User Data

Acrylic Acid

Production and Trends

In 1977, 283 million pounds of acrylic acid were produced (USITC, 1977). Industry capacity to produce acrylic acid is presently 394 million pounds (SRI, 1978).

Growth in acrylic acid production is closely aligned with acrylate production, which is expected to have an annual growth rate of 6-8% (Chem. Prof., 1977).

Uses

Acrylic acid has the following uses (Lawler, 1977): production intermediate for ethyl and methyl acrylate (52%), for n-butyl and isobutyl acrylate (26%), for n-ethylhexyl and other acrylates (5%), and for miscellaneous uses such as polyacrylic acid and various polymers and resins (17%).

Additives

Because acrylic acid is readily polymerized, polymerization inhibitors are added to the product for storage or shipment. Inhibitors such as hydroquinone or the monomethyl ether of hydroquinone are used (Blackford, 1976). Concentrations of about 200 ppm are needed of the monomethyl ether (Nemec and Bauer, 1978).

Producers and Distributors

Acrylic acid is produced and distributed by the following companies (SRI, 1978):

Celanese Corp.	Clear Lake, Tex.
Dow Badische	Freeport, Tex.
Rohn & Haas	Deer Park, Tex.
Union Carbide	Taft, La.

Table 1. Acrylic Acid and Its Esters

	Acrylic acid	Methyl acrylate	Ethyl acrylate
Synonyms	Ethylenecarboxylic acid 2-Propenoic acid Vinylformic acid	Acrylic acid, methyl ester Methyl propenate 2-Propenoic acid, methyl ester	Acrylic acid, ethyl ester 2-Propenoic acid, ethyl ester
CAS Number	79-10-7	96-33-3	140-88-5
RTECS Number	AS43750	AT28000	AT07000
Molecular Formula	$C_3H_4O_2$	$C_4H_6O_2$	$C_5H_8O_2$
Chemical Structure	$CH_2{:}CHCO_2H$	$CH_2{:}CHCOOCH_3$	$CH_2{:}CHCOOCH_2CH_3$
Physical and Chemical Properties			
Molecular Weight	72.06	86.09	100.13
Physical State	Liquid	Liquid (monomer)	Liquid (monomer)
Boiling Point, °C	141	70° at 608 mm	99.8
Melting Point, °C	13	-76.5	-71.2
Vapor Pressure	4.61 mm at 25°C	100 mm at 28°C	38.5 mm at 25°C
Evaporation Rate			
Solubility	Infinite (H_2O)	6 g/100 ml H_2O at 20°	2 g/100 ml H_2O at 20°
Specific Gravity	1.0621 (16/4°C)	0.9561 (20/4°C)	0.9405 (20/4°C)
Stability			

Table 1. Acrylic Acid and Its Esters (Cont'd)

	n-Butyl acrylate	Isobutyl acrylate	2-Ethylhexyl acrylate
Synonyms	Acrylic acid, butyl ester 2-Propenoic acid, butyl ester	Acrylic acid, isobutyl ester 2-Propenoic acid, isobutyl ester	Acrylic acid, 2-ethylhexyl ester 2-Propenoic acid, 2-ethylhexyl ester
CAS Number	141-32-2	106-63-8	103-11-7
RTECS Number	UD31500	AT21000	AT08550
Molecular Formula	$C_7H_{12}O_2$	$C_7H_{12}O_2$	$C_{11}H_{20}O_2$
Chemical Structure	$CH_2:CHCOOC_4H_9$	$CH_2:CHCO_2CH_2CH(CH_3)_2$	$CH_2:CHCO_2CH_2CH(C_2H_5)C_4H_9$
Physical and Chemical Properties			
Molecular Weight	128.19	128.17	184.31
Physical State	Liquid		Liquid
Boiling Point, °C	146 to 148	70° at 60 mm	130° at 50 mm
Melting Point, °C	-64.6		-90°C
Vapor Pressure	5.63 mm at 25°C		1 mm at 50°C
Evaporation Rate			
Solubility	0.14 g/100 ml H_2O at 20°		
Specific Gravity	0.8986 (20/4°C)	0.8896 (20/4°C)	0.8869 (20/20°C)
Stability			

Table 1. Acrylic Acid and Its Esters (Cont'd)

	2-Hydroxyethyl acrylate	2-Hydroxypropyl acrylate
Synonyms	Acrylic acid, 2-hydroxyethyl ester Ethylene glycol monoacrylate 2-Propenoic acid, 2-hydroxyethyl ester	Acrylic acid, 2-hydroxypropyl ester 2-Propenoic acid, 2-hydroxypropyl ester Propylene glycol monoacrylate
CAS Number	818-61-1	999-61-1
RTECS Number	AT17500	AT19250
Molecular Formula	$C_5H_8O_3$	$C_6H_{10}O_3$
Chemical Structure		
Physical and Chemical Properties		
Molecular Weight	116.13	130.16
Physical State		
Boiling Point, °C		
Melting Point, °C		
Vapor Pressure		
Evaporation Rate		
Solubility		
Specific Gravity		
Stability		

Table 1. Acrylic Acid and Its Esters (Cont'd)

	Acrylic acid, 2-chloro-, methyl ester	Acrylic acid, 2-cyano-, methyl ester
Synonyms	Acrylic acid, 2-chloro-, methyl ester 2-Propenoic acid, 2-chloro-, methyl ester	Acrylic acid, 2-cyano-, methyl ester 2-Propenoic acid, 2-cyano-, methyl ester
CAS Number	80-63-7	137-05-3
RTECS Number	AS63800	AS70000
Molecular Formula	$C_4H_5O_2Cl$	$C_5H_5O_2N$
Chemical Structure	$CH_2:CClCO_2CH_3$	
Physical and Chemical Properties		
Molecular Weight	120.54	111.11
Physical State		
Boiling Point, °C	57 to 59 at 55 mm	
Melting Point, °C		
Vapor Pressure		
Evaporation Rate		
Solubility		
Specific Gravity	1.189 (20/4°C)	
Stability		

Additional distributors include (OPD, 1978):

Carbonit Houston
Degussa Corp.
Miki Sangyo USA
Sattra Trading Co.
Suburban Chem.
Universal Preservachem

Manufacturing Processes

There are two commercially important processes currently used to produce acrylic acid: the propylene oxidation process and the modified Reppe process (Blackford, 1976).

The propylene oxidation process is essentially a two-stage reaction as shown below (Nemec and Bauer, 1978):

$$CH_2=CHCH_3 + O_2 \longrightarrow CH_2=CHCHO + H_2O$$

$$CH_2=CHCHO + 1/2\ O_2 \longrightarrow CH_2=CHCO_2H$$

In the first reactor, a mixture of propylene, air, and steam is converted mainly to acrolein. The effluent from the first reactor is then passed directly to the second reactor, where the acrolein is oxidized to acrylic acid. The products are absorbed in water to give about 20% aqueous acrylic acid. The acrylic acid is extracted using an organic solvent and then separated via vacuum distillation. The acrylic acid thus produced is 98-99% pure. About 90% of domestic capacity to produce acrylic acid uses this route (SRI, 1978).

In the modified Reppe process, acetylene, carbon monoxide, nickel carbonyl, and an acid are reacted to produce acrylic acid. An alcohol can be included in the reactants to produce the ester directly.

Acrylic Acid Esters

Production and Trends

The following table lists available production figures for acrylic acid esters.

Ester	Millions of lbs.	Reference
Ethyl acrylate	260.2	USITC (1977)
n-Butyl acrylate	260.1	USITC (1977)
2-Ethyl-1-hexylacrylate	47.4	USITC (1977)
Methyl acrylate	45.0	Blackford (1976)
Isobutyl & other acrylates*	20.0	Blackford (1976)

*primarily 2-hydroxyethyl and 2-hydroxypropyl acrylate

Acrylates production, in total, is expected to grow at a rate of 6-8% per year (Chem. Prof., 1977), or, perhaps, at a rate as high as 10% per year (Nemec and Bauer, 1978).

Industrial capacity to produce acrylates is 1.12 billion pounds per year (SRI, 1978).

Uses

Acrylates are used primarily to prepare emulsion and solution polymers (Nemec and Bauer, 1978). Various use applications follow (Chem. Prof., 1977):

Coatings	41%	Paper	5%
Textiles	20%	Adhesives	4%
Exports	13%	Leather	3%
Fibers	4%	Misc.	6%
Polishes	4%		

Ethyl and n-butyl acrylate are used primarily to make emulsion polymers that find use in latex paints, textiles, adhesives, fabric finishes, coatings and binders, paper coatings, floor polishes, leather finishes, and construction sealants and caulkings. They are also used in copolymers for enamels and elastomers (Lawler, 1977).

Methyl acrylate is used in production of higher acrylates, copolymers, and barrier resins as well as surfactants for shampoos and oven cleaners. Isobutyl and ethylhexyl acrylate are used to make emulsion polymers. Specialty acrylates, such as 2-hydroxyethyl and 2-hydroxypropyl acrylate, are used to make plastics and resins (Lawler, 1977).

Additives

As with acrylic acid, hydroquinone and its monomethyl ether are added to acrylates as polymerization inhibitors for storage and transport (Nemec and Bauer, 1978).

Producers and Distributors

The following companies are producers of the primary commercial acrylates (SRI, 1978):

Celanese Corp.	Clear Lake, Tex.
	Pampa, Tex.
Dow Badische	Freeport, Tex.
Dow Chem.	Freeport, Tex.
Rohm & Haas	Deer Park, Tex.
Union Carbide	Taft, La.

Specialty acrylates are manufactured by Aceto Chem., Sartomer Indust., Thiokol Corp., and Ware Chem. (SRI, 1978).

Manufacturing Processes

Acrylic acid esters are commercially manufactured by three processes: direct esterification, modified Reppe process, and transesterification (Blackford, 1976; Nemec and Bauer, 1978). In the direct esterification method, acrylic acid, the appropriate alcohol, and a catalyst such as H_2SO_4 are fed into an ester reactor where the ester is formed. The reactor product is distilled in a dehydration column to separate water and the ester. The ester is further purified via distillation to obtain recyclables, impurities, and the product ester.

In the modified Reppe process, acetylene is reacted with an alcohol, carbon monoxide, and nickel carbonyl to obtain directly the desired acrylate. The reaction generally is as follows:

$$4HC{\equiv}CH + 4ROH + CO + Ni(CO)_4 + 2HCl \longrightarrow 4CH_2{=}CHCOOR + H_2 + NiCl_2$$

The higher acrylates can be produced by transesterification starting with methyl or ethyl acrylate. The reaction may be represented as follows:

$$CH_2{=}CHCOOCH_3 + ROH \xrightarrow{H^+} CH_2{=}CHCOOR + CH_3OH$$

Control Technology

Protection required for safe handling of acrylic acid and its esters commonly includes use of impervious gloves, shoe soles, and clothing; splash-proof goggles; and good ventilation of the workplace (Nemec and Bauer, 1978).

8. Biological Effects of Exposure

a) Acute Effects

A summary of acute toxicity data for acrylic acid and its esters is presented in Table 2.

Treon and coworkers (1949) conducted extensive tests on the toxicity of methyl and ethyl acrylate. Oral administration of fatal doses of methyl acrylate (0.28 gm/kg) or ethyl acrylate (0.42 gm/kg) produced the following symptoms in rabbits: lethargy, running movements of the legs, tremors, spasms of the diaphragm, labored respiration, and cyanosis as well as hypothermia and a decrease in packed cell volume of the blood. Death occurred in 2.8-12 hours. Autopsies revealed deep congestion and small hemorrhagic extravations of the stomach, duodenum and upper jejunum; degenerative changes in the heart, liver, spleen, and kidneys; hypostatic congestion and atelectasis of the lungs; and moderate congestion and edema of the brain and meninges. Examination of rabbits two months after the administration of sublethal doses revealed slightly to moderately severe central hepatocellular degeneration and minimal degeneration of the renal tubules.

Table 2. Acute Toxicity

Species	Route	Dose	Result	Reference
Acrylic acid				
rat	oral	340 mg/kg	LD_{50}	Carpenter et al., 1974
rat	ihl	6000 ppm/5 hr	LC_{Lo}	Gage, 1970
rat	ipr	22 mg/kg	LD_{50}	Singh, et al., 1972
mouse	oral	2400 mg/kg	LD_{50}	NIOSH, 1977
mouse	ipr	128 mg/kg	LD_{50}	NIOSH, 1977
rabbit	skin	280 mg/kg	LD_{Lo}	Carpenter et al., 1974
Ethyl acrylate				
rat	oral	1020 mg/kg	LD_{50}	NIOSH, 1977
rat	ihl	1000 ppm/4 hr	LC_{Lo}	NIOSH, 1977
mouse	ihl	25 mg/m^3/2 hr	LC_{Lo}	NIOSH, 1977
mouse	ipr	648 mg/kg	LD_{50}	Lawrence et al., 1972
rabbit	oral	400 mg/kg	LD_{50}	NIOSH, 1977
rabbit	ihl	1204 ppm/7 hr	LC_{Lo}	Treon et al., 1949
guinea pig	ihl	1204 ppm/7 hr	LC_{Lo}	Treon et al., 1949
Methyl acrylate				
rat	oral	300 mg/kg	LD_{50}	Smyth et al., 1948
rat	ihl	1000 ppm/4 hr	LC_{Lo}	Treon et al., 1949
mouse	ipr	265 mg/kg	LD_{50}	Lawrence et al., 1972
rabbit	oral	280 mg/kg	LD_{Lo}	Treon et al., 1949
rabbit	ihl	2522 ppm/1 hr	LC_{Lo}	Treon et al., 1949
rabbit	skin	1300 mg/kg	LD_{Lo}	Smyth et al., 1948
Butyl acrylate				
rat	oral	3730 mg/kg	LD_{50}	NIOSH, 1977
rat	ihl	1000 ppm/4 hr	LD_{Lo}	NIOSH, 1977
mouse	ipr	926 mg/kg	LD_{50}	Lawrence et al., 1972
rabbit	skin	2000 mg/kg	LD_{50}	Carpenter et al., 1974

Table 2. Acute Toxicity (Cont'd)

Species	Route	Dose	Result	Reference
Isobutyl acrylate				
rat	oral	7460 mg/kg	LD_{50}	NIOSH, 1977
rat	ihl	2000 ppm/4 hr	LC_{Lo}	NIOSH, 1977
mouse	ipr	854 mg/kg	LD_{50}	Lawrence et al., 1972
rabbit	skin	890 mg/kg	LD_{50}	NIOSH, 1977
2-Ethylhexyl acrylate				
rat	oral	5660 mg/kg	LD_{50}	Lawrence et al., 1972
mouse	ipr	1506 mg/kg	LD_{50}	NIOSH, 1977
rabbit	skin	16 gm/kg	LD_{50}	NIOSH, 1977
2-Hydroxyethyl acrylate				
rat	oral	650 mg/kg	LD_{50}	NIOSH, 1977
rat	ihl	500 ppm/4 hr	LD_{Lo}	NIOSH, 1977
rabbit	skin	1010 mg/kg	LD_{50}	NIOSH, 1977
2-Hydroxypropyl acrylate				
rat	oral	590 mg/kg	LD_{50}	NIOSH, 1977
rabbit	scu	160 mg/kg	LD_{50}	Smyth et al., 1969
2-Cyanoacrylic acid, methyl ester				
rat	ipr	100 mg/kg	LD_{Lo}	NIOSH, 1977

Both methyl and ethyl acrylate produced irritation, erythema, edema, thickening, and vascular damage when applied to the skin of rabbits. The minimum lethal amount of ethyl acrylate was 40.7-49.8 gm/kg applied over 24 hours (duration of contact 4-5 hours) (Treon et al., 1949).

b) Subchronic Effects

Repeated oral administration of methyl acrylate (0.023 gm/kg/day for 33 days, total of 24 doses) and ethyl acrylate (0.0315 gm/kg/day for 35 days, total of 25 doses) did not produce any toxic symptoms in rabbits other than small weight losses and retardation of growth (Treon et al., 1949). This is in agreement with a later study conducted by Borzelleca and coworkers (1964) in which rats received 6-2000 ppm of ethyl acrylate in their drinking water for a period of two years. There were no noticeable effects on mortality or any alterations in the blood, urine, or tissues of treated animals; however, small decreases in the weight of both males and females were noted in the group receiving 2000 ppm.

A summary of toxicity data from a subchronic inhalation study by Treon and coworkers (1949) is presented in Table 3.

The toxic effects of acrylic acid and 2-ethylhexyl acrylate were studied by Gage (1970). Rats exposed to 80 ppm of acrylic acid for 20 six-hour periods did not exhibit any toxic symptoms, while those exposed to 300 ppm for 20 six-hour periods suffered some nasal irritation, lethargy, and retarded weight gain. Autopsies did not reveal any changes in body organs. Exposure to 130 ppm of 2-ethylhexyl acrylate for 13 six-hour exposures produced initial weight loss, lethargy, and slight respiratory difficulty. Organs and blood and urine analyses proved normal.

c) Chronic Effects

i. Carcinogenicity

Data from an ongoing chronic inhalation study of rats and mice exposed to ethyl acrylate are presented in Table 4 (Ramsy et al., 1978). The animals were exposed 6 hours per day, 5 days per week. No lesions in the lungs or neoplasms have been observed in either the mice or rats, although degeneration and some focal squamous metaplasia of the nasal mucosa were recorded.

ii. Mutagenicity

No data were encountered.

iii. Teratogenicity

In a study conducted by Singh and coworkers (1972), rats were injected (i.p.) on days 5, 10, and 15 of gestation with three dose levels of acrylic acid equivalent to 1/3, 1/5, and 1/10 of the LD_{50}. The data are summarized in Table 5. Dose-related increases in resorptions, and gross and skeletal abnormalities in addition to a reduction in fetal weight were observed. Hemangiomas and elongated and fused sternebrae and frontal ribs were the primary fetal malformations.

Table 3. Subchronic Inhalation Toxicity (Treon et al., 1949)

Species	Dose	Result	
Methyl acrylate			
rabbit	2620.7 ppm/2.75 hours	4/4 Died	Conjunctival and nasal irritation, labored respiration, convulsions, and cyanosis
	2522.1 ppm/1 hour	2/4 Died	Conjunctival and nasal irritation, labored respiration, and convulsive kicking
	577.8 ppm/2 x 7 hours	4/4 Died	Excitation, eye and nasal irritation, labored respiration, lethargy
	236.8 ppm/11 x 7 hours	5/5 Died	Eye closure, conjunctival and nasal irritation, labored breathing, lethargy
	95.1 ppm/50 x 7 hours	0/4 Died	No effect
	31 ppm/130 x 7 hours	0/4 Died	No effect
guinea pig	577.8 ppm/3 x 7 hours	2/2 Died	Eye closure, slight lacrimation, nasal and oral irritation, labored breathing, lethargy, and few convulsive movements
	236.8 ppm/12 x 7 hours	2/2 Died	Eye closure, nasal irritation, labored respiration, lethargy
	95.1 ppm/50 x 7 hours	0/2 Died	No effect
	31.0 ppm/130 x 7 hours	0/2 Died	No effect
rat	577.8 ppm/7 x 7 hours	2/2 Died	Eye closure, conjunctival and nasal irritation, labored respiration, lethargy
	236.8 ppm/12 x 7 hours	0/2 Died	Eyes closed, nasal irritation, lethargy
	95.1 ppm/50 x 7 hours	0/2 Died	No effect
	31.0 ppm/30 x 7 hours	0/2 Died	No effect
monkey	31.0 ppm/130 x 7 hours	0/1 Died	No effect

Table 3. Subchronic Inhalation Toxicity (Treon et al., 1949) (Cont'd.)

Species	Dose	Result	
Ethyl acrylate			
rabbit	1204 ppm/7 hours	4/4 Died	Coughing, conjunctival and nasal irritation, ataxia, convulsive movements, spasmodic respiration, and diarrhea
	501 ppm/4 x 7 hours	4/4 Died	Salivation, conjunctival and nasal irritation, gasping, convulsive movements, diarrhea
	272 ppm/8-17 x 7 hours	4/4 Died	Moderate conjunctival and nasal irritation, lethargy, gasping, convulsive movements
	74 ppm/50 x 7 hours	0/4 Died	No effect
	24.5 ppm/130 x 7 hours	0/4 Died	No effect
guinea pig	1204 ppm/7 hours	2/2 Died	Hiccoughs, rales, conjunctival and nasal irritation, convulsive movements, and spasmodic respiration
	501 ppm/13 x 7 hours	2/2 Died	Salivation, rales, conjunctival and nasal irritation, lethargy, and gasping
	272 ppm/28 x 7 hours	1/2 Died	Moderate conjunctival and nasal irritation, lethargy, and moderate gasping
	74 ppm/50 x 7 hours	0/2 Died	No effect
	26.2 ppm/130 x 7 hours	0/2 Died	No effect
rat	1204 ppm/2 x 7 hours	2/2 Died	Salivation, conjunctival and nasal irritation, prostration, convulsive movements, and spasmodic respiration
	501 ppm/13 x 7 hours	1/2 Died	Salivation, conjunctival and nasal irritation, lethargy, and labored respiration
	272 ppm/28 x 7 hours	0/2 Died	Slight salivation, slight conjunctival and nasal irritation, lethargy, and diarrhea

Table 3. Subchronic Inhalation Toxicity (Treon et al., 1949) (Cont'd.)

Species	Dose	Result	
rat (cont'd)	74.8 ppm/50 x 7 hours	0/2 Died	No effect
	26.2 ppm/62-130 x 7 hours	0/2 Died	No effect
monkey	1204 ppm/2.2 x 7 hours	1/1 Died	Conjunctival and nasal irritation, convulsive movements, spasmodic respiration
	272 ppm/28 x 7 hours	0/1 Died	Slight irritation of mucous membranes and lethargy
	26.2 ppm/130 x 7 hours	0/1 Died	No effect

Table 4. Chronic Inhalation

Species	Dose	Result
rat	75 ppm/3 months	Very slight inflammation and degeneration of the nasal mucosa.
rat	225 ppm/3 months	Moderate inflammation, necrosis and degeneration of nasal mucosa. Mild focal squamous metaplasia of mucosa.
rat	75 ppm & 225 ppm/6 mo.	Dose-related reduction in weight gain, degeneration and inflammation of nasal mucosa with focal squamous metaplasia of nasal mucosa.
rat	25 ppm/6 months	Slight focal degeneration of nasal mucosa.
mice	25 ppm/6 months	Slight focal degeneration and inflammation of nasal mucosa.
mice	75 ppm/6 months	Slight focal degeneration, necrosis and inflammation with hyperplasia and metaplasia of nasal mucosa.
mice	225 ppm/6 months	Moderate focal degeneration, necrosis and inflammation with hyperplasia and metaplasia of nasal mucosa.

Table 5. Embryonic Fetal Toxicity and Teratogenicity

	Dose (ml/kg)	No. of Corpus lutea	Resorptions	Dead Fetuses	Living Fetuses	Mean Wt. Fetuses (gm)	Gross Abnormal.	Skeletal Abnormal.
Untreated controls	--	60	0	0	59 (100%)	4.83	0	0
Distilled water	0.822	53	3 (7.7%)	0	36 (92.3%)	3.82	0	1 (5.0%)
Normal saline	0.822	60	4 (7.4%)	0	50 (92.6%)	4.15	1 (2%)	2 (7.7%)
Cottonseed oil	0.822	53	0	0	50 (100%)	3.85	1 (2%)	4 (15.4%)
Acrylic acid	0.0075	52	3 (6.0%)	3(6%)	44 (88.0%)	3.80	4 (9.1%)	4 (16.7%)
	0.0045	56	2 (3.6%)	0	54 (96.4%)	3.96	2 (3.7%)	3 (10.7%)
	0.0023	57	0	0	57 (100%)	4.09	0	3 (9.7%)

iv. Other Effects

No data were encountered.

d) Human Effects

Very little information concerning the toxic effects of acrylic acid and its esters on humans was encountered. Both methyl and ethyl acrylate have a penetrating, sweetish odor and are readily detected at low concentrations -- 31 ppm and 25 ppm, respectively.

The effects of methyl-2-cyanoacrylate vapor on humans were tested in a simulated workbench situation (ACGIH, 1974). The odor threshold was 1-3 ppm. At a concentration of 3 ppm, nasal irritation occurred; at 5 ppm, eye irritation was noted.

9. Threshold Limit Values, OSHA Standards, NIOSH Recommended Standards

	TLV's* (ACGIH, 1977)	OSHA (OSHA, 1976)	NIOSH
Ethyl acrylate	25 ppm (or 100 mg/cu m)	25 ppm (or 100 mg/cu m)	N/A
Methyl acrylate	10 ppm (or 35 mg/cu m)	10 ppm (or 100 mg/cu m)	N/A
Methyl 2-cyano-acrylate	2 ppm (or 8 mg/cu m)	N/A	N/A
Butyl acrylate	10 ppm (or 55 mg/cu m)	N/A	N/A

*The Threshold Limit Value of ethyl acrylate will prevent irritation and systemic effects; lacrimation and other primary effects will be prevented by the TLV for methyl acrylate. The TLV for methyl-2-cyanoacrylate is adequate to prevent undue irritation. The TLV value for butyl acrylate is the first trial limit proposed for this chemical. If no evidence questioning the appropriateness of this value comes to light within two years, it will be reconsidered for inclusion in the adopted list (ACGIH, 1977).

10. Other Standards

Several companies, including Celanese Corporation, Dow Badische Company, Rohm and Haas Company, and Union Carbide Corporation, have established internal exposure standards of 5 ppm (8-hour TWA) for ethyl acrylate. This is lower than the OSHA Standard and ACGIH Threshold Limit Value of 25 ppm, which has been found to cause irritation in exposed employees (Ramsy et al., 1978).

11. Occupational Exposures

The following figures for annual occupational exposures were provided in an oral communication from Vera Hudson, Division of Criteria Documentation and Standards Development, NIOSH (oral communication, 1976):

	Yearly Occupational Exposures
Acrylic acid	65640
Acrylic acid esters	31800
Methyl acrylate	9840
Ethyl acrylate	19860
Butyl acrylate	8490
2-ethylhexyl acrylate	11670
2-hydroxyethyl acrylate	2610
2-hydroxypropyl acrylate	2400
Methyl cyanoacrylate	1890

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. NA	2. NA	3. Recipient's Accession No. NA PB81 147894
4. Title and Subtitle: Potential Occupational Hazards, Volume II, Chemical Classes Acrylic Acid and its Esters			5. Report Date: December 1979
			6. NA
7. Author(s): Anonymous			8. Performing Organization Rept. No. NA
9. Performing Organization Name and Address: Center for Chemical Hazard Assessment, Syracuse Research Corporation, Syracuse, New York			10. Project/Task/Work Unit No. NA 11. Contract(C) or Grant(G) No. (C) 210-78-0019 (G)
12. Sponsoring Organization Name and Address: National Institute for Occupational Safety and Health, Rockville, Maryland			13. Type of Report & Period Covered: Contract Final Report 14. NA

15. Supplementary Notes

NA

16. Abstract (Limit: 200 words)

ABSTRACT: This information profile on*acrylic acid (79107) and its esters is part of a group of 46 such profiles that provide information about chemicals or industrial processes considered to be potential occupational hazards. Each profile contains summary data on known and suspected health effects, the extent of worker exposure and the industrial importance of either a single chemical, class of chemicals, or a particular industrial process. The report was developed for use by occupational safety and health professionals in industry, and labor and other areas, to provide them with a synopsis of information in their workplaces.

17. Document Analysis a. Descriptors

Toxicology
Physiological-efficts
Chemical-properties
Occupations
Industrial-processes
Work-environment
Safety-research

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Available to the public	NA	21
	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce