



Epichlorohydrin Properties

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Introduction

Epichlorohydrin (EPI) is a hazardous material due to its toxicity, flammability and reactivity. Appropriate precautions must be taken to safely store, transport, deliver and handle this product.

In all cases, international, national, regional and local regulations related to transport, storage, handling, health, safety and environmental protection must be strictly observed.

This brochure contains several sections discussing the properties, storage, handling and transport of epichlorohydrin. For further information, consult the Material Safety Data Sheet (MSDS). For details related to bulk storage, please refer to our Bulk Storage brochure.

Personnel Training

Personnel handling epichlorohydrin (transport, handling, sampling, analysis, etc.) should receive special product training (regularly updated) and carry out periodic first aid, fire fighting and decontamination practices.

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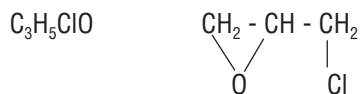
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1.0 Identification



Molecular mass: 92.53

Synonyms

Epichlorohydrin
Epichlorhydrine
Glycerol epichlorohydrin
1-Chloro-2,3-epoxypropane
1,2-Epoxy-3-chloropropane
Chloromethyloxirane
Oxyde de chloropropylene
Chloropropylene oxide
EPI, ECH

Identification Numbers

CAS No. 106-89-8
UN No. 2023
EC No. 603-026-00-6
EINECS No. 203-439-8

2.0 International Regulations

2.1 Transportation Classification

2.1.1. European Union

The labeling guidelines set by the European Union are:

- Symbols and indications of danger



- Nature of special risks and safety advice concerning dangerous chemical substances

T	Toxic
R 10	Flammable
R 23/24/25	Toxic by inhalation, ingestion and skin contact
R 34	Causes burns
R 43	May cause sensitization by skin contact
R 45	May cause cancer
S 9	Keep the container in a well-ventilated place
S 44	If unwell, seek medical advice (show the label if possible)
S 53	Avoid exposure – obtain special instructions before use

2.1.2 United Nations

Item	Value	Interpretation
Product Name	Epichlorohydrin	Proper shipping name
U.N. Number	2023	Identification No.
Hazard Class	6.1	Poisonous material
Packing Group	II	

2.1.3 European/International

Transport is regulated by:

- ADR - European agreement concerning international transport of goods by road
- RID - European agreement concerning international transport of goods by rail

The ADR/RID regulations are:

Item	Value	Interpretation
Product Name	Epichlorohydrin	Proper shipping name
U.N. Number	2023	U.N. identification number
Hazard Class	6.1 (16°C)	Poisonous material
Labeling	Flammable liquid and poison	
Orange panel	63	Orange panel (ADR) Main risk: 6 = toxic material Secondary risk: 3 = flammable material (flash point between 21 and 55°C)

2.1.4 United States

The Department of Transportation (DOT) in the US has the following regulations regarding the transport of epichlorohydrin.

Item	Value	Interpretation
Product Name	Epichlorohydrin	Proper shipping name
U.N. Number	2023	U.N. identification number
Hazard Class	6.1	Poisonous material
Packing Group	II	
Label	Poison, flammable liquid, marine pollutant	

2.2 Handling Classification in North America

CERCLA Hazardous Substance (40 CFR Part 302)

Listed substance	Yes
RCRA waste number	U041
Reportable quantity	100 pounds

SARA, Title III, Sections 302/303

(40 CFR Part 355 – Emergency Planning and Notification)

Extremely hazardous substance	Yes
Reportable quantity	100 pounds
Threshold planning quantity	1000 pounds

SARA, Title III, Sections 311/312

(40 CFR Part 370 - Hazardous Chemical Reporting: Community Right-To-Know)

Hazard category	Immediate (acute) health hazard Fire hazard
Threshold planning quantity	500 pounds

SARA, Title III, Section 313

(40 CFR Part 372 - Toxic Chemical Release Reporting: Community Right-To-Know)

Extremely hazardous substance	Yes
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CAA, 112(r)

(40 CFR 68.150 – Risk Management Plan)

Use and storage	20,000 pounds
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WHMIS Classification (Canada)

B2	Flammable liquid
D1A	Very acutely toxic material
D2A	Other toxic effects – carcinogen
E	Corrosive

3.0 Physical Properties

Property	Unit	Value
Slight odor similar to ether and chloroform		
Boiling point (atm. pressure)	°C	116
Melting point	°C	- 57
Vapor pressure (at 20°C)	mbars	17
Specific gravity (at 20°C)	None	1.18
Vapor density (air = 1)	None	3.2
Viscosity (at 20°C)	mPa.s	1.12
Solubility in water (at 20°C)	%	6.5
Solubility of water in epichlorohydrin (at 20°C)	%	1.5
Liquid surface tension (at 20°C)	N.m ⁻¹	0.035
Azeotrope with water		
• Boiling point	°C	88
• Concentration of epichlorohydrin	g.kg ⁻¹	750
Specific heat of the liquid (at 25°C)	J.g ⁻¹ .K ⁻¹	1.56
Specific heat of the vapor (at 100°C)	J.g ⁻¹ .K ⁻¹	1.19
Latent heat of vaporization	J.g ⁻¹	410
Heat of combustion	kJ.g ⁻¹	19
Flash point (ABEL, closed vessel)	°C	26
Flash point (TAG, closed vessel)	°C	31
Auto-ignition temperature	°C	385
Decomposition temperature	°C	225
Flammability limits in air	% v/v	3.8 - 21.0
Coefficient of volume expansion (at 20°C)*	K ⁻¹	0.00094

Abbreviations:

mbars: millibars

mPa.s: milliPascal.second

J: Joule

K: Degrees Kelvin (absolute temperature)

*The coefficient of volume expansion of the liquid has been measured between 4 and 37°C. For example, a rise in temperature from 4 to 37°C induces a volume increase of approximately 3.1%, i.e., 620 liters for a volume of 20 m³ (at 4°C).

4.0 Vapor Density

4.1 Pure Vapor Density

$$\frac{\text{Molar mass of epichlorohydrin}}{\text{Average molar mass of air}} = \frac{92.53}{29} = 3.2$$

4.2 Density of Air Saturated with Epichlorohydrin Vapor

Partial pressure of epichlorohydrin	=	17 mbars	x	92.53	=	1,573
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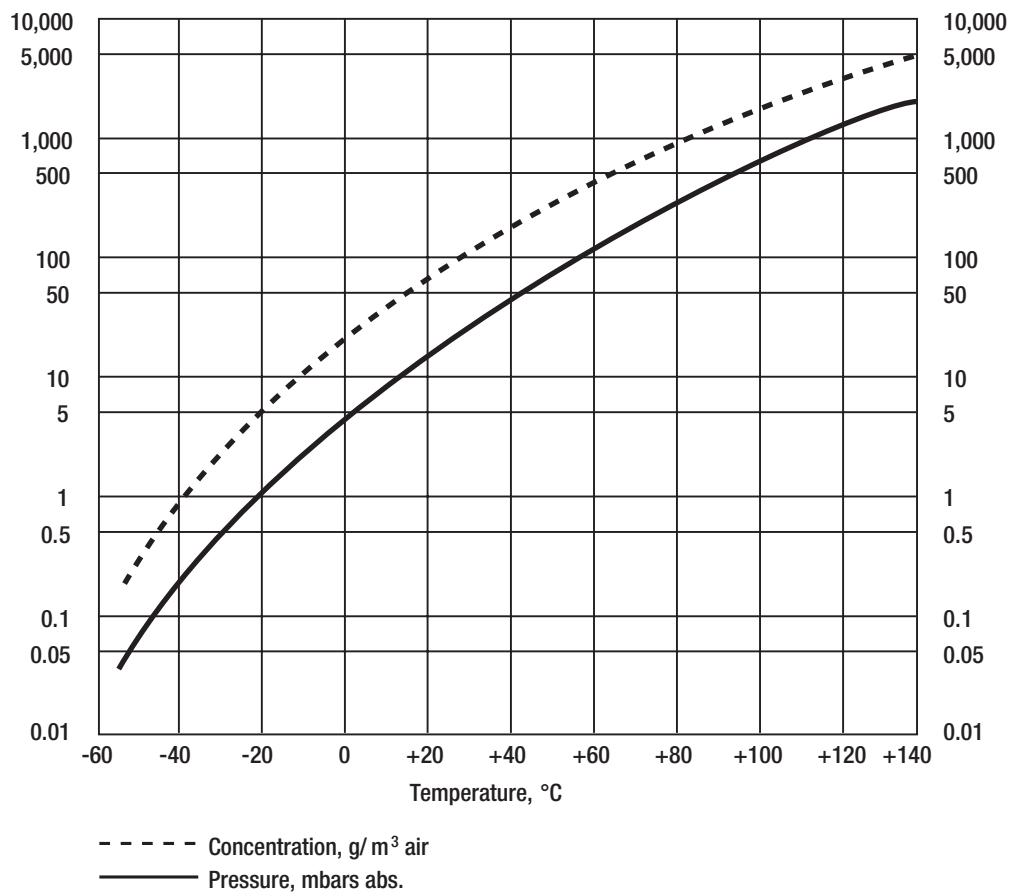
Partial pressure of air	=	983 mbars	x	29	=	28,507
Total pressure	=	1,000 mbars			=	30,080

Pressure of pure air	=	1,000 mbars	x	29	=	29,000
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Density of saturated air compared with pure air: $\frac{30,080}{29,000} = 1.04$

Air saturated with epichlorohydrin is therefore slightly denser than pure air (+ 4%) and can remain at ground level especially in a stagnant environment.

4.3 Effect of Temperature on Vapor Pressure



4.4 Flammability Risks

4.4.1 Properties

Epichlorohydrin is flammable in the presence of sources of heat, flames and sparks. Its flash point in a closed cup is 26°C (78.8°F) using the ABEL method (ISO 2719 - ASTM D56 - DIN 51755 - NF 07-036), and 31°C (87.8°F) using the TAG (Tagliabue) Closed Cup method (TCC). Due to polymerization, containers may explode if involved in fire.

In mixtures with air, the vapor phase can produce a flammable or moderately explosive mixture when the concentration of epichlorohydrin is between 3.8% and 21% (by volume). The lower flammability limit (3.8%) is reached when the temperature of the liquid corresponds to that of the flash point (around 31°C). Beyond the upper flammability limit (21%), the mixture is no longer flammable because the concentration of atmospheric oxygen is too low. However, conditions of flammability may be reached by dilution of the vapors (draught of air, etc.) and from aerolization.

**Composition of the Gaseous Phase at Equilibrium with the Liquid Phase
(In a Storage Tank, for example)**

Temperature, °C	Vapor Tension, mbar	Concentration in the Vapor Phase, % vol. (V/V)
0	4.8	0.48
10	9.3	0.93
20	17.3	1.73
25	22.7	2.27
30	30.7	3.07
35	40	4.0
40	51	5.1
50	84	8.4
60	132	13.2
70	200	20.0
80	293	29.3
Flammability limits in air		3.8 to 21

In view of the significant risk due to its flammability, it is recommended to handle and store epichlorohydrin under nitrogen. Epichlorohydrin should be kept away from sources of heat, flames and sparks.

In addition, when handling epichlorohydrin (pumping, etc.), electrostatic charges may be produced. These may cause sparks, which are a source of ignition. To avoid this risk, it is essential to ensure that all equipment is properly grounded and bonded.

4.4.2 Classification

The US National Fire Protection Association (NFPA®) Hazard Index is:

<i>Health</i>	3	Short exposure could cause serious temporary or residual injury.
<i>Flammability</i>	3	Liquid can be ignited under almost all normal temperatures.
<i>Reactivity</i>	2	Readily undergoes violent chemical change at normal or elevated temperatures and pressures, or reacts violently with water, or may form explosive mixtures with water.

5.0 Thermal Decomposition

Starting from about 225°C, "dry" epichlorohydrin may polymerize. In the presence of water, even at moderate temperatures, it may undergo thermal decomposition by hydrolysis, especially if the medium is acidic or basic. Epichlorohydrin burns to form water, carbon oxides and hydrogen chloride (HCl: an irritant gas).

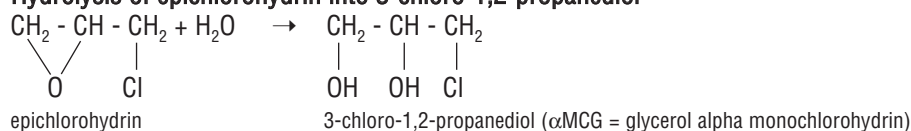
6.0 Chemical Reactivity

Epichlorohydrin may react violently in the presence of certain substances (notably acids or bases, pure or in concentrated solutions), especially at high temperatures. Principal categories of materials that can react with epichlorohydrin are: acids, bases such as alkalis, amines and ammonia, alcohols, carbon monoxide, metallic oxides and hydroxides, salts, especially metal halides (e.g., FeCl₃), and aluminum, magnesium, copper, tin, zinc and their alloys.

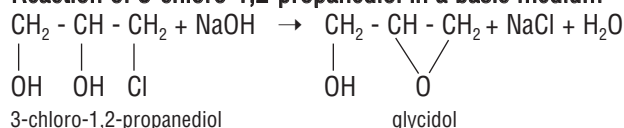
7.0 Degradation in Aqueous Solutions

Whether or not it contains a base or an acid, epichlorohydrin in an aqueous solution is hydrolyzed into glycerin in several stages.

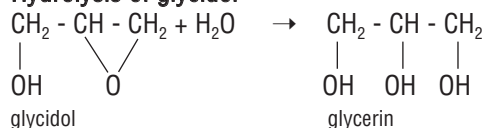
Hydrolysis of epichlorohydrin into 3-chloro-1,2-propanediol



Reaction of 3-chloro-1,2-propanediol in a basic medium

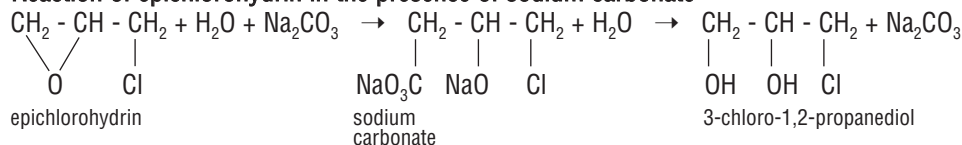


Hydrolysis of glycidol

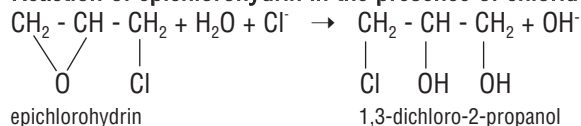


In the presence of other reactive substances, the following reactions are observed.

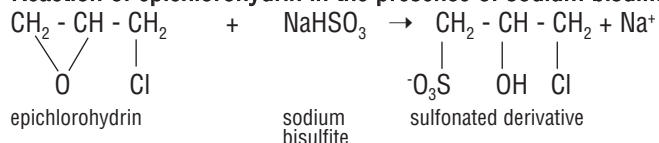
Reaction of epichlorohydrin in the presence of sodium carbonate



Reaction of epichlorohydrin in the presence of chlorides



Reaction of epichlorohydrin in the presence of sodium bisulfite



The hydrolysis of epichlorohydrin in an aqueous solution is catalyzed by bases and acids. Its hydrolysis rate is therefore a function of its concentration and the concentration of either the base or acid.

The following rate constants were calculated on the basis of the production of chloride ions in solution. They represent the rate of hydrolysis of epichlorohydrin **and** of 3-chloro-1,2-propanediol (intermediate product).

7.1 Acid Hydrolysis

$$V = \frac{-d(\text{EPI})}{dt} = k_1 (\text{EPI}) + k_3 (\text{EPI}) (\text{H}^+)$$

Where:

- V = reaction rate, mol.dm⁻³.s⁻¹
- (EPI) = epichlorohydrin concentration, mol.dm⁻³
- (H⁺) = acid concentration, eq.dm⁻³ (can be calculated from the pH: (H⁺) = 10^{-pH})
- t = time, s (seconds)
- k₁ = rate constant for reaction with water, s⁻¹
- k₃ = rate constant for catalysis by an acid, dm³.mol⁻¹.s⁻¹

$$\log k_3 = 10.46 - \frac{4,060}{T}$$

Where:

- T = absolute temperature, K (degrees Kelvin)

In a medium containing hydrochloric acid (HCl), sulfuric acid (H₂SO₄) or nitric acid (HNO₃), it is also necessary to take into account the reaction of the corresponding anions. In the presence of HCl, epichlorohydrin reacts with the chloride ion (Cl⁻) to form 1,3-dichloro-2-propanol.

7.2 Base Hydrolysis

7.2.1 Dilute Solutions of Sodium Hydroxide

$$V = \frac{-d(\text{EPI})}{dt} = k_1 (\text{EPI}) + k_2 (\text{EPI})(\text{OH}^-)$$

Where:

- V = reaction rate, mol.dm⁻³.s⁻¹
- (EPI) = epichlorohydrin concentration, mol.dm⁻³
- (OH⁻) = base concentration, eq.dm⁻³ (can be calculated from the pH: (OH⁻) = 10^{pH - 14})
- t = time, s (seconds)
- k₁ = rate constant for reaction with water, s⁻¹
- k₂ = rate constant for catalysis by a base, dm³.mol⁻¹.s⁻¹

$$\log k_1 = 7.176 - \frac{3,850}{T}$$

$$\log k_2 = 9.942 - \frac{4,050}{T}$$

Where:

- T = absolute temperature, K (degrees Kelvin)

For example: In the case of a molar solution of caustic soda:
1 mol.dm⁻³ = 40 g NaOH/liter → (OH⁻) = 1 eq.dm⁻³

7.2.2 Concentrated Solution of Sodium Hydroxide

The rate of epichlorohydrin decomposition in excess concentrated caustic soda solutions was measured at about 20°C. The rate constants were determined on the basis of the appearance of chloride ions in the solution and therefore represent the rate of hydrolysis of epichlorohydrin and 3-chloro-1,2-propanediol (intermediate product).

s = second(s)

Solution	Rate constant, s ⁻¹	Half-life
NaOH 1N (pH = 14)	1.4 x 10 ⁻⁴	1.4 h
NaOH 2N	6.1 x 10 ⁻⁴	19 m
NaOH 3 to 5N	~9.0 x 10 ⁻⁴	~13 m
NaOH 8N	2.2 x 10 ⁻⁴	54 m

m = minute(s)

h = hour(s)

The highest reaction rate is obtained in a solution of NaOH 4N.

7.2.3 Alkaline Hydrolysis in the Presence of a Carbonate

In an alkaline medium and at the same pH, hydrolysis in the presence of sodium carbonate (Na₂CO₃) is more rapid than in the presence of NaOH. This results in the appearance of an additional term k₄ (CO₃²⁻), corresponding to catalysis by the CO₃²⁻ anion.

$$V = k_4 (\text{CO}_3^{2-}) (\text{EPI})$$

Where:

V = reaction rate, mol.dm⁻³.s⁻¹

(CO₃²⁻) = sodium carbonate concentration, mol.dm⁻³

(EPI) = epichlorohydrin concentration, mol.dm⁻³

k₄ = rate constant, dm³.mol⁻¹.s⁻¹

$$\log k_4 = 9.262 - \frac{3.920}{T}$$

T = absolute temperature, K (degrees Kelvin)

7.2.4 Alkaline Hydrolysis of 3-chloro-1,2-propanediol (α MCG)

$$V = k_5 (\text{OH}^-) (\alpha \text{ MCG})$$

Where:

V = reaction rate, mol.dm⁻³.s⁻¹

(OH⁻) = base concentration, eq.dm⁻³ (can be calculated from the pH: (OH⁻) = 10^{pH - 14})

(α MCG) = concentration of 3-chloro-1,2-propanediol, mol.dm⁻³

k₅ = rate constant, dm³.mol⁻¹.s⁻¹

$$\log k_5 = 12.33 - \frac{3.800}{T}$$

Where:

T = absolute temperature, K (degrees Kelvin)

The decomposition of α MCG is particularly rapid in a strongly basic medium. The concentration of α MCG is therefore always very low under these conditions.

7.2.5 Hydrolysis of Glycidol in a Neutral or Basic Solution

$$V = k_6 (\text{H}_2\text{O}) (\text{GLY})$$

Where:

(H₂O) = concentration of H₂O, mol.dm⁻³ (in excess of water, (H₂O) = 55.506 mol.dm⁻³)

(GLY) = concentration of glycidol, mol.dm⁻³

k₆ = rate constant, dm³.mol⁻¹.s⁻¹

$$\log k_6 = 4.912 - \frac{3.850}{T}$$

Where:

T = absolute temperature, K (degrees Kelvin)

$$V = k_7 (\text{OH}^-) (\text{GLY})$$

Where:

(OH⁻) = base concentration, eq.dm⁻³ (can be calculated from the pH: (OH⁻) = 10^{pH - 14})

(GLY) = concentration of glycidol, mol.dm⁻³

k₇ = rate constant, dm³.mol⁻¹.s⁻¹

$$\log k_7 = 8.212 - \frac{3.550}{T}$$

Where:

T = absolute temperature, K (degrees Kelvin)

A basic medium favors the production of glycerin. If epichlorohydrin decomposition is carried out in a sodium carbonate medium (pH = 9 to 11.5), the production of glycerin will be less rapid than in a caustic soda medium (generally pH 12 to 14).

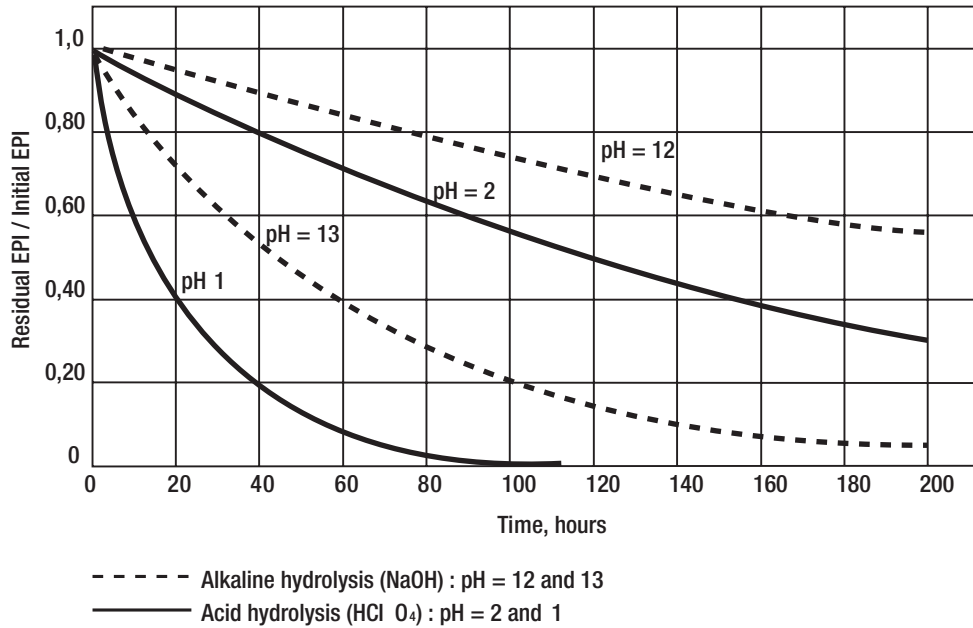
7.3 Typical Decomposition Rates

7.3.1 Comparison Between Acid and Base Hydrolysis

Temperature, °C	0	20	40
pH	k (Rate Constants), s ⁻¹		
0	4.0 x 10 ⁻⁵	4.1 x 10 ⁻⁴	3.2 x 10 ⁻³
1	4.1 x 10 ⁻⁶	4.2 x 10 ⁻⁵	3.2 x 10 ⁻⁴
2	5.2 x 10 ⁻⁷	5.2 x 10 ⁻⁶	3.9 x 10 ⁻⁵
3	1.6 x 10 ⁻⁷	1.5 x 10 ⁻⁶	1.1 x 10 ⁻⁵
4 to 10	1.2 x 10 ⁻⁷	1.1 x 10 ⁻⁶	7.6 x 10 ⁻⁶
11	1.3 x 10 ⁻⁷	1.2 x 10 ⁻⁶	8.6 x 10 ⁻⁶
12	2.5 x 10 ⁻⁷	2.4 x 10 ⁻⁶	1.8 x 10 ⁻⁵
13	1.4 x 10 ⁻⁶	1.4 x 10 ⁻⁵	1.1 x 10 ⁻⁴
14	1.3 x 10 ⁻⁵	1.4 x 10 ⁻⁴	1.0 x 10 ⁻³

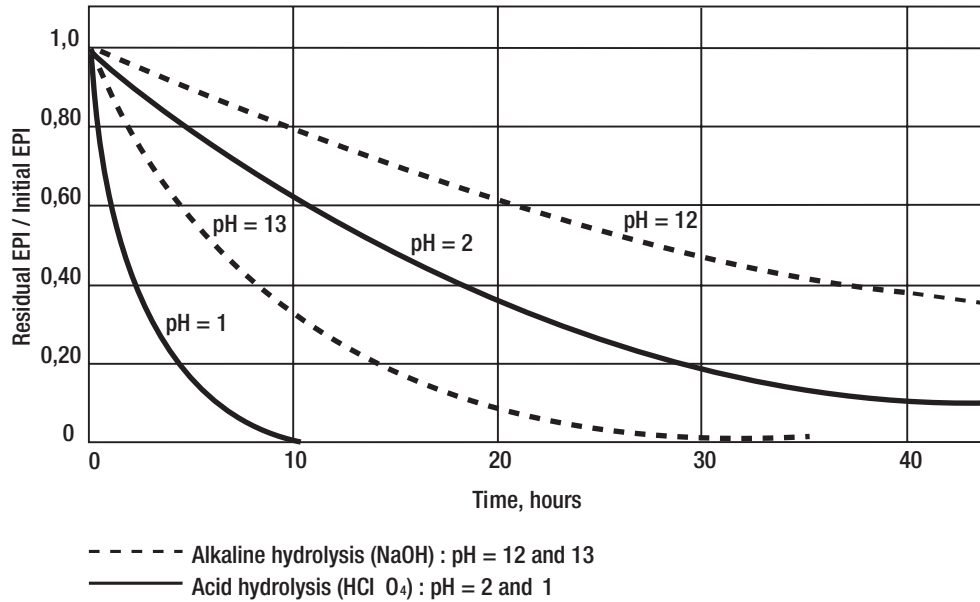
Epichlorohydrin Hydrolysis in an Aqueous Solution at Constant pH

Temperature : 10°C



Epichlorohydrin Hydrolysis in an Aqueous Solution at Constant pH

Temperature : 30°C



Temperature, °C	0	20	40
pH	Half-lives		
0	4.8 h	0.5 h	3.7 m
1	2.0 d	4.6 h	0.6 h
2	16 d	1.5 d	4.9 h
3	50 d	5.3 d	18 h
4 to 10	67 d	7.2 d	25 h
11	60 d	6.5 d	22 h
12	32 d	3.3 d	11 h
13	5.6 d	13 h	1.8 h
14	15 h	1.4 h	11 m

s = second(s)

m = minute(s)

h = hour(s)

d = day(s)

7.3.2 Decomposition Over Time

In the presence of a large excess of reactive aqueous solution, the rate of decomposition of epichlorohydrin can be calculated as follows (first order reaction):

$$\frac{(EPI)_t}{(EPI)_0} = e^{-kt}$$

Where:

$(EPI)_t$ = epichlorohydrin concentration at time t

$(EPI)_0$ = epichlorohydrin concentration at time 0 (initial)

$\frac{(EPI)_t}{(EPI)_0}$ = rate of progress (e.g., 0.1 for a rate of 10%)

e = 2.7182818... = natural logarithm base

t = reaction time (seconds)

k = rate constant for epichlorohydrin at a specific temperature and in a specific solution (expressed in s⁻¹).

The time required to provide a given rate of progress is calculated as follows:

$$t = -\frac{1}{k} \times L_N \frac{(EPI)_t}{(EPI)_0}$$

Where:

L_N = natural logarithm (Naperian)

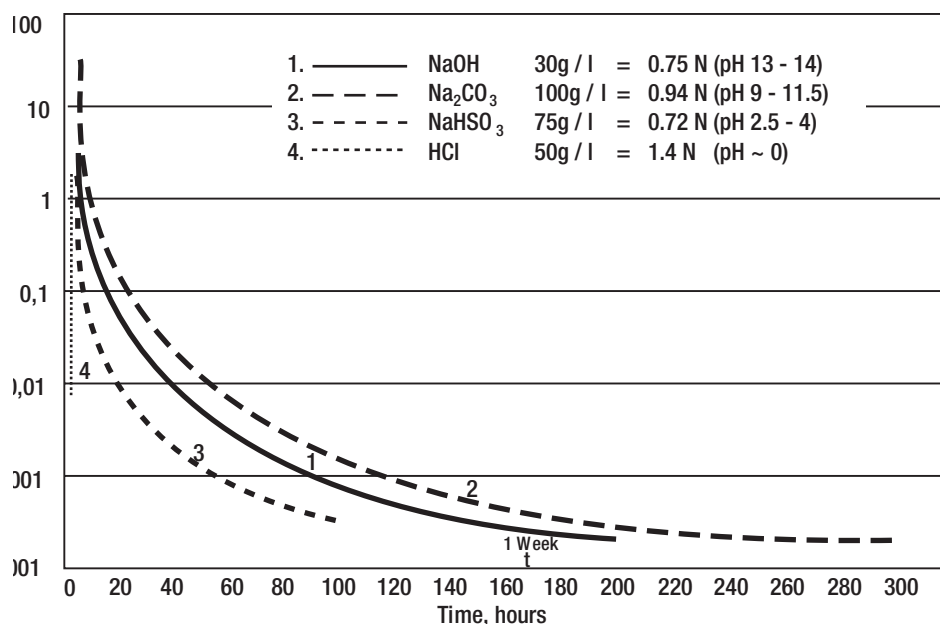
7.4 Decomposition of Epichlorohydrin in “Decontamination Solutions”

Various techniques have been used to rapidly decompose epichlorohydrin in an aqueous solution in the following cases:

- Gas scrubbing (gas-liquid extraction column)
- Purifying air coming from vacuum systems
- Purifying the gaseous phase of a tank (e.g., during filling, etc.)
- Decontamination of tanks, drums, etc.

Solution Used	Advantages	Disadvantages
Sodium carbonate (Na ₂ CO ₃)	Rapid decomposition of epichlorohydrin. Moderate pH. Solution obtained can be disposed of (after dilution).	Rather slow decomposition of 3-chloro-1,2-propanediol (moderate pH).
Caustic soda (NaOH)	Rather slow decomposition of epichlorohydrin and 3-chloro-1,2-propanediol.	Highly corrosive solution (very high pH) which must be neutralized and diluted before disposal.
Hydrochloric acid (HCl)	Very rapid decomposition of epichlorohydrin.	Production of 1,3-dichloropropane-2-ol which must be treated (e.g., by controlled incineration). Highly corrosive solution (very low pH) which must be neutralized and diluted before disposal.
Sodium bisulfite (NaHSO ₃)	Very fast decomposition of epichlorohydrin.	Solution must be treated: - neutralization (otherwise SO ₂ gas will form), - destruction of sulfonates formed as well as excess reducing agent, - dilution.

Decomposition of Epichlorohydrin in “Decontamination Solutions”



8.0 Compatible Materials

8.1 Materials of Construction

Epichlorohydrin is normally stored and transferred in containers made of mild steel or stainless steel. Corrosion (especially in mild steel) may appear in abnormally damp conditions.

Epichlorohydrin has a swelling effect on polymers and elastomers (pipes, gaskets, protective gloves and boots, etc.) that varies with the exact type of material.

Behavior of Elastomers in Contact with Epichlorohydrin

Material	Duration	Measures (% Variation)			Remarks
		Length	Width	Weight	
NEOPRENE	5 min	- 0.2	+ 0.6	+ 1.0	
	7 d	+ 4.8	+ 7.2	+ 20.0	
	7 d + dry	- 2.6	- 3.0	- 6.6	
HFP Fluorolastomer	5 min.	+ 0.3	0	+ 1.7	
	7 d	+ 17.3	+ 14.4	+ 34.8	
	7 d + dry	0	- 0.8	- 0.4	
Perfluorated elastomer	5 min.	+ 0.4	+ 1.2	0	
	7 d	+ 0.8	+ 0.6	+ 0.1	
	7 d + dry	- 1.2	+ 1.8	- 0.2	
EPDM	5 min.	+ 0.2	- 0.4	+ 0.1	
	7 d	+ 1.4	- 1.2	- 1.7	
	7 d + dry	- 3.7	- 3.0	- 8.4	
NITRILE	5 min.	+ 0.8	+ 0.4	+ 6.1	Significant deformation
	7 d	+ 37.6	+ 34.5	+ 150	
	7 d + dry	- 2.9	- 2.4	- 7.2	
SILICONE	5 min.	+ 0.6	+ 0.3	+ 2.3	
	7 d	+ 2.4	+ 2.5	+ 8.5	
	7 d + dry	0	0	- 0.6	
5 min. = total immersion for 5 minutes 7 d = total immersion for 7 days 7 d + dry = total immersion for 7 days and complete drying NEOPRENE Polychlorobutadiene (polychloroprene) HFP Fluorolastomer Hexafluoropropylenevinyl fluoride copolymer EPDM Ethylenepropylene copolymer NITRILE Butadieneacrylonitrile copolymer SILICONE Polysiloxane					

The above table indicates good resistance of the elastomers tested, but significant deformation of the following materials:

NITRILE >> HFP Fluorolastomer > NEOPRENE

Notes

The information given in the above table is indicative only, and is insufficient to establish with any certainty whether or not a material is suitable. The reasons for this are:

- During tests, materials were totally immersed, while in practice they are only in contact with the material on one side, or over a part of their surface (pipes, gaskets, etc.). Therefore, materials which showed significant variations in dimensions or weight are not necessarily unsuitable for all applications.
- The behavior of the material also depends on the following properties:
 - Chemical formula
 - Molar mass
 - Distribution of molar mass
 - Levels of crystallinity
 - Presence of additives (fillers, fibers, etc.)
 - Presence of other polymers

It is essential to carry out behavior tests under real conditions of use:

- Total or partial immersion
- Short-term or continuous contact
- Material protected mechanically or not (tube with metal braiding, gasket located in a housing, etc.)
- Used under mechanical stress or not.

Recommended materials include:

Gaskets

- Spiral metallic gaskets
- P.T.F.E. (polytetrafluoroethylene),
- HFP Fluorolastomer, lined with P.T.F.E.
- Perfluorated elastomer

Pipes

- P.T.F.E. (polytetrafluoroethylene)
- Stainless steel tubing (may be covered with P.T.F.E.)
- Chlorosulfonated polyethylene elastomer

8.2 Personal Protective Equipment

In view of the properties of epichlorohydrin, it is essential to take all reasonable precautions to reduce exposure to a minimum. Epichlorohydrin easily penetrates clothing, gloves and shoes. It is necessary to wear suitable protective clothing whenever handling the product. The following materials are recommended based on permeability testing done according to ASTM method F739-91.

Material	Protection (hours)
Butyl rubber	>8
PVA (polyvinyl alcohol)	>4
P.T.F.E. (polytetrafluoroethylene)	>4

Caution

Do not allow epichlorohydrin to come in contact with leather. Contaminated leather may appear dry but the product diffuses to the skin and can lead to chemical burns.

9.0 Environmental Issues

9.1 Risks

Epichlorohydrin has low persistence in the environment due to its relatively fast hydrolysis. However, because of its reactive properties, an epichlorohydrin spill into the environment could have an immediate impact. It is therefore important to avoid dispersing the product and to treat any spills according to national, regional and/or local regulations.

9.1.1 Atmospheric Fate

Epichlorohydrin is rapidly destroyed in the atmosphere and therefore does not accumulate. Its decomposition products are believed to have no significant effect on the environment. Due to its limited solubility in water, it is subject to washout by rain.

Half-life: maximum 4 days.

9.1.2 Aquatic Fate

When released into water, a percentage of epichlorohydrin evaporates and decomposes in air.

Air/water partition coefficient (at 20°C) 0.00091 (g/m³/g/m³)

HENRY coefficient (at 20°C) 2.4 Pa.m³.mol⁻¹
(air/water partition coefficient : vapor pressure/concentration in water)

The remaining portion contaminates water for a relatively short period, given the rate at which it hydrolyzes. See section 7.0 for details and half-lives.

It has been observed that bacterial strains contribute to the decomposition of epichlorohydrin into 3-chloro-1,2-propanediol, glycidol and finally glycerin (duration: several days).

Examples of half-lives (data from the literature)

In an open system (taking evaporation into account):

- In a river 29 hours
- At a depth of 1 meter (at 20°C) 2.1 days
- At 0.4 meters with air injection (at 20°C) 12 hours

In a closed system (with no evaporation)

- In pure water (at 20°C) 3 to 8.2 days
- In reconstituted sea water (NaCl = 3%) 5.3 days
(formation of 1-chloro-2,3-propanediol + 1,3-dichloro-2-propanol)

Biodegradability

Biological oxygen demand (BOD)₅ 0.03 g O₂/g

Chemical oxygen demand (COD) 1.16 g O₂/g

Level of biologically oxidizable material (BOD/COD) 0.026

This low ratio indicates slow biodegradability of epichlorohydrin. However, it is easily biodegradable by suitable inoculum: 89% of COD eliminated in 24 hours.

Acute ecotoxicity

Epichlorohydrin is harmful to aquatic organisms during acute exposure.

LC₅₀ (daphnia, 24 h) 30-40 mg/l

LC₅₀ (fish, 96 h) 10-30 mg/l

Chronic ecotoxicity

Partition coefficient octanol/water

$$\log P(o/w) = 0.3$$

This coefficient provides information on the tendency of the substance to migrate into living cells. The low value given for epichlorohydrin indicates a low potential for bioaccumulation.

Bioaccumulation potential

$$\log_{10} BCF = 0.66$$

The BCF (Biological Concentration Factor) represents the concentration of the substance in an organism compared with its concentration in water (at equilibrium). The low value for epichlorohydrin indicates a low potential for bioaccumulation in aquatic organisms.

9.1.3 Terrestrial Fate

Adsorption coefficient in soils and sediment

$$KOC = 123$$

(KOC: Organic Carbon Normalized Absorption Coefficient for soils.)

This value indicates that epichlorohydrin is not readily absorbed on soil and has little persistence in the ground. The product penetrates the ground and decomposes fairly rapidly.

9.2 Regulations and Guidelines

9.2.1 Air Emissions

No current European standard except:

DE (TA Luft)	}	Class III
IT		
CH		

Permitted releases for Class III:

- If the output is greater than 25 g/h: max. concentration 5 mg/m³ (1.3 ppm)
- If the output is lower than 25 g/h: no established limit

(TA Luft: Technische Anleitung zur Reinhaltung der Luft).

US: individual limits in each state; considered as a hazardous environmental pollutant under the Clean Air Act, and an air contaminant by OSHA (Occupational Safety and Health Administration.)
Refer to 49 CFR 60-63 and 29 CFR 1910.

9.2.2 Effluent Emissions

No current European standard. However, taking into account the characteristics of the product and by analogy with other regulated substances, the concentration in released water should not exceed 0.2 mg/l.

Germany - class WGK: 3 (very dangerous)

(WGK: WasserGefahrungsklassen: risks during transport, storage, etc.).

US: classified as a marine pollutant by the Department of Transportation.

Epichlorohydrin is listed in several sections of the Clean Water Act as a contaminant.

Refer to 40 CFR 100-149, 400-503.

10.0 Health Risks

10.1 Acute Toxicity

Epichlorohydrin (liquid or gas) is an irritant to the eyes, skin and mucous membranes of the respiratory and digestive tracts. It is absorbed through intact skin and, in some cases, induces allergic reactions. In addition, it may cause burns which appear a few hours after exposure. Epichlorohydrin may affect both respiratory and nervous systems, and may cause abdominal cramps and convulsions.

Caution: contaminated leather goods may appear dry, but if worn may release epichlorohydrin and cause severe burns. Always discard contaminated leather items. Consult Material Safety Data Sheet (MSDS) for additional information.

Acute toxicity:

LD ₅₀ oral (rat)	90 mg/kg
LD ₅₀ skin (rabbit)	515-754 mg/kg
LC ₅₀ inhalation (rat, 4 h)	635 ppm

10.2 Chronic Toxicity

The usual symptoms are fatigue, headache, chronic respiratory problems and, in some cases, blood and liver complaints.

Carcinogenic effects have been observed with animals only.

Certain animal studies show that high doses of epichlorohydrin affect fertility. However, epidemiological studies have not been proven to have a similar effect in humans.

No effect on reproduction has been observed either in humans or animals.

10.3 Regulations and Guidelines

Classification

- HMIS[®] has given epichlorohydrin the following rating:

Health	3
Flammability	2
Reactivity	2
PPE	required

- WHMIS has given epichlorohydrin the following rating:

B2	Flammable
D1A	Very acutely toxic material
D2A	Other toxic effects – carcinogen
E	Corrosive

Acceptable levels of concentration with no damaging effect on health have been established by various organizations.

Maximum Concentrations of Epichlorohydrin in Air Permitted in the Workplace

Limit	Organization	Unit ppm (volume) = cm ³ /m ³ (mg/m ³)
TLV-TWA*	(ACGIH - US)	0.5 (1.9) (skin)**
PEL-TWA	(OSHA- US)	5 (19) (skin)**
IDLH	(NIOSH-US)	75
Olfactory threshold		10 to 25

* TLV-TWA (Threshold Limit Value-Time Weighted Average) is the time-weighted average concentration for a normal 8-hour workday and 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The olfactory threshold varies from one person to another and can be as high as 25ppm; consequently, dangerous levels of concentration may go undetected. It is advisable to monitor the concentration in air at frequent intervals.

** (skin): epichlorohydrin (liquid or vapor) is easily absorbed through the intact skin; it therefore contributes to a person's global exposure.

Classification For Carcinogenic Factor

ACGIH	(US)	A3
EPA	(US)	B2
IARC	(US)	2A
NTP	(US)	2B
MAK	(DE)	A2
WHMIS	(Canada)	D2A

Because of the effects observed in animals, the European Union (EU) has classed epichlorohydrin as "possibly carcinogenic in humans". In countries following the EU directives, labeling for this product carries the message R45 "May cause cancer."

Abbreviations

ACGIH	American Conference of Governmental Industrial hygienists-US
EPA	Environmental Protection Agency - US
IARC	International Agency for Research on Cancer
IDLH	Immediately Dangerous to Life and Health
HMIS	US National Paint and Coating Association: Hazardous Material Identification System
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration - US
PEL	Permissible Exposure Limit - US
STEL	Short Term Exposure Limit - US
TLV®	Threshold Limit Value - US
TWA	Time Weighted Average - US
WHMIS	Workplace Hazardous Information System

Notes

In the USA, regulation exposure limits are set by OSHA. The values given by the American ACGIH experts are only **recommended** limits. However, these limits are used as official limits in several other countries that have no national regulations. The regulations of the country concerned must always be respected.

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