SAFETY DATA SHEET

BROMINE

1. Identification of the substance & the company

Chemical Name	**BROMINE**
Chemical formula	Br_2
CAS Number	7726-95-6
Chemical family	Halogens
Molecular weight	159.81 g/mol
Type of product and use	For manufacturing of pharmaceuticals, flame retardants, dyes, fumigants, sanitizers, petrol antiknock compounds and other organic derivatives
Manufacturer	Archean Chemical Industries Limited (100% EOU) Greater Rann of Kutch, Near Hajipir, Taluka: Bhuj, Dist. Kutch, Gujarat – 370 605, India
Telephone	+91 2836 234259/234158/233841
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Emergency Contact	Mr. Vijaya Raghavan +91 9444010241 vijayaraghavan@archeanchemicals.com

2. Hazards Identification

Adverse human health effects	▪ Very toxic by inhalation ▪ Liquid bromine rapidly attacks the skin and other tissues, producing irritation and burn which heal very slowly. Even comparatively low concentrations of vapour are highly irritating and painful to the respiratory track
GHS Classification	▪ Acute toxicity (Inhalation) : Category 1 ▪ Skin corrosion/irritation : Sub-category 1A ▪ Serious eye damage/eye irritation : Category 1 ▪ Acute aquatic toxicity : Category 1
	Hazard statement(s) ▪ H303 May be harmful if swallowed ▪ H314 Causes severe skin burns and eye damage ▪ H330 Fatal if inhaled ▪ H400 Very toxic to Aquatic life

Prevention:

- P260 Do not breathe dust/ fume/ gas/ mist/ vapours/ spray. P264 Wash skin thoroughly after handling.
- P271 Use only outdoors or in a well-ventilated area.
- P273 Avoid release to the environment.
- P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
- P284 Wear respiratory protection.

Response:

- P301 + P330 + P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
- P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
- P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/doctor.
- P305 + P351 + P338 + P310 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P310 Immediately call a POISON CENTER/doctor.
- P363 Wash contaminated clothing before reuse.
- P391 Collect spillage.

Storage:

- P403 + P233 Store in a well-ventilated place. Keep container tightly closed.
- P405 Store locked up.

Disposal:

- P501 Dispose of contents/ container to an approved waste disposal plant

Symbols

Signal Word: Danger

NFPA		Health	3	Can cause serious or permanent injuiry
		Flammability	0	Will not burn under typical fire conditions
		Instability	0	Normally stable, even under fire conditions
		Special	OX	Possesses oxidizing properties

3. Composition / Information on Ingredients

CAS-No	EC-No	Index-No	Weight %	Classification
Bromine				
7726-95-6	231-778-1	035-001-00-5	99.9	T+; R26, C; R35 N; R50 (In accordance with DSD 67/548/EEC)

4. First Aid Measures

4.1 Description of first aid measures

Eye Contact Holding the eyelids apart, flush eyes promptly with copious flowing water for at least 20 minutes. Get medical attention immediately.

Skin Contact It is highly important to wash immediately, with water, any contaminated skin or eyes and get medical attention. Flood Skin with water directing a stream of water under the clothing while it is being removed. Wash skin thoroughly with mild soap and plenty of water for at least 15 minutes. Get medical attention immediately. NO DECANTAMINANTS OTHER THAN WATER SHOULD BE USED ON HUMANS. Avoid reusing contaminated clothing.

Inhalation In case of inhalation, remove person to fresh air. Keep them quiet and warm. Apply artificial respiration if necessary and get medical attention immediately

Ingestion If no respiratory compromise is present, wash mouth with water. DO NOT INDUCE VOMITING. Get medical attention immediately. Note: Never give an unconscious person anything to drink.

NOTE: Never give an unconscious person anything to drink

Recommended Antidote There is no specific antidote for bromine. Treatment is symptomatic and supportive.

4.2 Most important symptoms and effects, both acute and delayed

Ocular Corrosive. Causes serious eye damage
Symptoms include redness, pain and blurred vision.
Direct contact may result in serious corneal burns.
May cause temporary or even permanent eye damage
Lachrimation occurs at less than 1 ppm

Dermal Corrosive. Direct contact may result in serious skin burns
Symptoms include redness, pain and edema

Inhalation Fatal if inhaled. Corrosive to mucous membrane and upper respiratory tract. Symptoms include sore throat, dizziness, headache, nosebleed, coughing, abdominal pain and sometimes a rash. May cause delayed pulmonary edema.

Ingestion Corrosive by ingestion.
Symptoms include sore throat, abdominal pain, vomiting and diarrhea. May cause severe burns to the mucous membranes of the mouth, esophagus and stomach.

4.3. Indication of immediate medical attention and special treatment needed

Notes to the physician Corrosive
In case of ingestion DO NOT induce vomiting.
No specific antidote.
Treat symptomatically and supportively.

The first aid procedure should be established in consultation with the doctor responsible for industrial medicine

5. Fire – Fighting Measures

Suitable extinguishing media

- Material is not combustible. Use extinguishing media appropriate to surrounding fire conditions such as Water Spray and Dry Powder Fire Extinguishers. Firefighting water run off should be prevented from polluting nearby water sources.

Unusual fire and explosion hazards

- Although non-combustible itself, this fuming liquid will react with combustible materials and may cause them to ignite.
- Hydrogen, many organic compounds and some metals will burn in a bromine atmosphere.
- If exposed to a fire, the vapor pressure increases rapidly and might lead to the rupture of the receptacle.

Firefighting procedure	▪ Stay upwind. Avoid any bodily contact. ▪ Wear self-contained breathing apparatus and appropriate protective clothing (Refer Section 8 – 'Personal Protective Equipment' for more details) ▪ Wear full chemical protective suit if contact with material or dense fumes smoke anticipated. ▪ Use water from side and from safe distance to keep fire exposed containers cool
Specific hazards during fire- fighting	▪ Burning produces irritant fumes ▪ Exposure to decomposition products may be a hazard to health
Specific extinguishing methods	▪ Use water spray to cool unopened containers ▪ Collect contaminated fire extinguishing water separately. This must not be discharged into drains ▪ Prevent fire extinguishing water from contaminating surface water or the ground water system.

6. Accident Release Measures

Personal precautions	▪ Evacuate area. ▪ Keep people away from and upwind of spill/leak. ▪ Full protective clothing including self-contained breathing apparatus must be used. (See Section 8 – 'Personal Protective Equipment' for more details)
Environmental precautions	▪ Toxic to aquatic life ▪ Discharge into the environment must be avoided. Do not contaminate water. ▪ Prevent entry into sewers and watercourses
Methods for cleaning up	Consult an expert. Collect liquid in sealable containers. Neutralize and wash away In the case of bromine spillage, ammonia gas vapors should be released to the area from a safe distance. 1. When handling a leaking bottle, drum, or cylinder of bromine, personal protective clothing, goggles, and NIOSH or equivalent approved self-contained breathing equipment must be worn. 2. Clear contaminated area of non-essential personnel.

3. Maintain a slight ammonia atmosphere throughout the cleanup. Carefully release anhydrous ammonia gas to neutralize bromine vapor, but do not over apply anhydrous ammonia. The ammonia gas will convert bromine to white ammonium bromide “smoke.” Do not allow liquid bromine and liquid ammonia to combine; a violent reaction will occur. Ammonia (16 to 25% by volume) can form an explosive mixture with air.
4. Pour hypo solution, lime and water slurry, or soda ash solution over the spill. Hypo-bromine reactions produce hydrobromic acid. Dry sodium thiosulfate and liquid bromine produce a violent reaction; do not mix them. Hypo solution is prepared by dissolving 220 grams of technical sodium thiosulphate in a litre of water and a 100gm of soda ash. The solution will remain stable for four to six weeks.
5. Using cold water, wash neutralized bromine into a sump for transfer to an approved waste disposal facility where the waste can be processed.
6. Ventilate the area to remove the ammonium bromide and any bromine fumes. Clean the floors and equipment with soap and water.

7.Handling and Storage

Precautions for safe handling

- Handle in accordance with good industrial hygiene and safety practice.
- Avoid contact with skin, eyes and clothing. Use with adequate ventilation.
- Avoid breathing vapors and any other bodily contact. Keep the temperature above -7.3 ^{o}C to prevent freezing
- It is recommended that All personnel handling bromine should be fully trained and provided with suitable protective clothing. Totally enclosed systems should be used for processes involving bromine.
- Pipe works and tanks should be checked regularly for leaks.
- In laboratories, bromine containers should be kept closed and only handled in fume cupboards or under extraction hoods.
- Warm containers should be allowed to cool to room temperature before they are opened.
- Before transferring bromine between containers, a check should be made that the receiving container has room for it.

Conditions for safe storage, including any incompatibilities

- Store in a dry, cool, well-ventilated area away from incompatible materials (see “Incompatible Materials” under section 10).
- Containers should be stored upright and all be clearly labelled.
- Glass, ceramic, nickel or lead containers are suitable for bromine. Lead –lined steel tanks can be used. Only highly fluorinated plastics (PVDF) will resist corrosion.
- A free space of 10% by volume should be left in the container.
- Outside shaded or detached storage areas are preferred. A detached storage area is either an outside shaded area or a separate building containing no incompatible materials and located away from all the other structures.
- In the case of detached storage, the building construction should be fire resistant and provisions made for potential fire-fighting activities, according to relevant local and national codes the fire-fighting installation should include provisions for an adequate supply of water. Fire extinguishers and hydrants should be distributed around the area. Fire-fighting water run-off should be prevented from polluting water sources. Floors should be of impervious construction, preferably concrete.
- Container should not be dropped or handled roughly.

8.Explore Controls / Personal Protection

Exposure Limits :

Components	ACGIH-TLV Data	Korea OEL	OSHA (PEL) Data
BROMINE 7726-95-6	0.1 ppm (0.66 mg/m^3) TWA 0.2 ppm (1.3 mg/m^3) STEL	0.1 ppm TWA 0.3 ppm STEL	0.1 ppm (0.7 mg/m^3)

Ventilation requirements

- Ventilation required at floor level.
- Ventilation must be sufficient to maintain atmospheric concentration below recommended exposure limit

Personal protective equipment:

- **Respiratory protection**

Options for respiratory protection are

- Self-contained breathing apparatus - permitting the wearer to carry a supply of oxygen or air compressed in the cylinder and the self-generating type which produces oxygen chemically
- Positive pressure hose masks—The air shall be supplied

by blowers requiring no internal lubrication

- Air-line masks supplied with clean compressed air. These are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply
- Industrial canister type gas masks — Equipped with full face pieces fitted with the proper canister for absorbing bromine vapour. Maybe used only for short term for concentration less than 1 percent by volume. Not suitable for emergencies.
- Chemical cartridge respirators — May be used to avoid inhaling disagreeable concentrations of bromine vapour. Not recommended for protection where high toxic quantities may be encountered.

- **Hand protection**	▪ Neoprene/ nitrile gloves.
- **Eye protection**	▪ Chemical safety goggles or face shields with safety goggles
- **Skin and body protection**	▪ Suits made of PVC/ neoprene and properly designed.
- **Foot Protection**	▪ Leather or rubber safety shoes with built-in steel toe caps. Rubber may be worn over leather safety shoes. Leather shoes should be discarded after any contact with bromine.

Hygiene measures

- Avoid bodily contact.
- Do not eat, smoke or drink where material is handled, processed or stored.
- Wash hands thoroughly after handling and before eating or smoking.
- Safety shower and eye bath should be provided.
- Do not eat drink or smoke until after-work showering and changing clothes.

Engineering Measures

- Effective exhaust ventilation system
- Ensure that eyewash stations and safety showers are close to the workstation location.

9.Physical and Chemical Properties

Appearance	Heavy red-brown, fuming liquid with a sharp, harsh irritating odour
Melting point/range	**-7.3** °C
Boiling point/range	**58.8 °C**
Evaporation rate (ether=1)	High
Vapour Pressure	175 mmHg (20 °C)
Vapour density	5.5
Relative Density	3.119
Density	3.14 g/cm3 (15 °C)
Flash Point	None
Solubility	Easily soluble in diethyl ether, very slightly soluble in cold water, freely soluble in alcohol, chloroform, carbon disulfide, carbon-tetrachloride, concentrated hydrochloric acid and aqueous solution of Bromide
Solubility in water	3.3 g/100 ml at 20 °C
Partition coefficient	Log Pow – 1.3 (estimated)
pH	Not Applicable
Auto-ignition temperature	Not self-ignitable
Flammability (liquids)	Does not sustain combustion
Decomposition temperature	Not Relevant
Viscosity Viscosity, dynamic: Viscosity, kinematic:	1.02 mPa.s (20 °C) No data available
Explosive properties	Not explosive
Oxidizing properties	Oxidiser
Critical temperature	315 °C

10.Stability and Reactivity

Reactivity	▪ No dangerous reaction known under conditions of normal use ▪ In the presence of water reacts vigorously with phenols, amines, hydrocarbons, organic acids and aromatic and aliphatic ketones. ▪ Dry bromine reacts violently with many metals, notably aluminum, titanium, mercury and potassium and with phosphorus.
Chemical stability	▪ No decomposition if stored normally
Corrosivity	▪ Extremely corrosive in presence of aluminum, of zinc, of stainless steel (304) Of stainless steel (316), Highly corrosive in presence of Copper. ▪ Non-Corrosive in presence of glass
Possibility of hazardous reactions	▪ Hazardous polymerization does not occur
Conditions to avoid	▪ Extremes of temperature and direct sunlight. ▪ Exposure to moisture ▪ Contamination
Incompatible materials	▪ Reducing agents, Metals, Alcohols, Ammonia, Bases ▪ Combustible materials ▪ Phenols, amines, hydrocarbons, organic acids, aromatic and aliphatic ketones, aluminum, titanium, mercury, potassium and phosphorous
Hazardous decomposition products	▪ Hydrogen bromide

11.Toxicological Information

Acute toxicity:

- **Rat inhalation LC 50**	▪ 2700 mg/m3
- **Mouse inhalation LC 50**	▪ 750 ppm/9 min
- **Rat oral LD50**	▪ 2600 mg/kg

Ocular	▪ Corrosive ▪ Symptoms include redness, pain and blurred vision Lachrimation occurs at less than 1 ppm
Dermal	▪ Corrosive ▪ Symptoms include redness, pain and edema
Inhalation	▪ Corrosive to mucous membranes and upper respiratory tract Symptoms include sore throat, dizziness, headache, nosebleed, coughing, abdominal pain, and some time a rash. ▪ Liquid and concentrated bromine vapour may cause severe burns that ulcerate and are slow to heal.
Ingestion	▪ Corrosive by ingestion ▪ Symptoms as of inhalation
Chronic toxicity	▪ Prolonged exposure may cause chronic bronchitis, contact and allergic dermatitis
Mutagenicity	▪ Mutagenic in the mouse lymphoma L5178Y test system. ▪ Was found to be not mutagenic in the micronucleus test with mice erythrocytes in bone marrow.
Carcinogenity	▪ Not known to be a carcinogen Not classified as IARC ▪ Not included in NTP 14th report on carcinogens
Specific Target Organ Toxicity (STOT) - Repeat exposure	▪ Prolonged exposure may cause chronic bronchitis, contact and allergic dermatitis.

12.Ecological Information

Information on ecological effects	▪ Bromine is not biodegradable. Because of its high vapour density, bromine is not transferred to high atmospheric levels
Aquatic toxicity:	▪ Oxidants produced from bromine in water are known to be very toxic to aquatic organisms and very reactive
- **LC50, Fish**	▪ 310 µg/L (Oncorhynchus mykiss 24h)

- **48 hour-LC50, Daphnia magna**	▪ 520 µg/L (Lepomis macrochirus 24h) ▪ 1000 µg/L
Persistence and degradability	▪ Bromine is unstable in water hydrolysing rapidly
Biodegradability	▪ Bromine is an inorganic substance and does not undergo biodegradation to form carbon dioxide. ▪ Bromine in contact to water forms a mixture of brominated oxidants such as hydrobromic and hypobromous acids. Oxidants produced from bromine in water are known to be very toxic to aquatic organisms and very reactive. Inorganic bromide is the principal ultimate degradant from reaction of these species. Bromide occurs naturally in the environment. ▪ In the presence of natural waters or test media containing biological molecules, other brominated oxidant species may also be formed.
Bio accumulative potential	▪ Not expected to bioaccumulate
Mobility in soil	▪ Negative anions such as bromide are known not to sorb to soil. Bromide itself has been used to monitor ground water flow through soil; its mobility in soil is similar to water.
Note:	▪ Bromine is classified as “very toxic by inhalation". The Persistent, Bioaccumulative and Toxic (PBT) criteria for labeling as Toxic (T) are fulfilled. Bromine will not bioaccumulate, thus the PBT criteria for labeling as Bioaccumulative (B) is not fulfilled. Bromine hydrolyses in water rapidly. The substance does not fulfill the PBT criteria for labeling as Persistent (P).

13.Disposal Consideration

Waste Disposal	▪ Disposal can be a hazardous operation; seek specialist advice. ▪ Dilute and neutralize before transferring to an approved disposal facility. ▪ May be disposed of by absorption on vermiculite or other equivalent absorbent and disposed in sealed containers in

a secured landfill.
- Disposal should be in accordance with local, state or national legislation.

14.Transportation Information

UN No. 1744

IMDG

- Proper shipping name: Bromine
- Class: 8 - Corrosives
- Label: CORROSIVE (8); and TOXIC
- Packing Group: I
- Mark: MARINE POLLUTANT

ADR/RID

- Proper shipping name: Bromine
- Class: 8 - Corrosives
- Classification Code: CT1
- Danger Label Model No.: 6.1+8
- Packing group: I
- Hazard identification No. 886
- Marking: Environmentally hazardous substance

ICAO/IATA

- Class: 8 Subsidiary Risk: 6.1
- Hazard label(s): Corrosive & Poison
- Passenger aircraft - Forbidden
- Cargo aircraft – Forbidden

DOT

- Proper shipping name: Bromine
- Class: 8 - Corrosives
- Label: CORROSIVE (8) and POISON
- Shipping description: Inhalation Hazard; Hazard zone A
- Packing Group: I
- Emergency Guide No.154
- Marking: Marine Pollutant

GB

- As per GB 6944-2012 standard “classification and Code of Dangerous goods”.
- As per GB 12268-2012 standard “List of dangerous goods”

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

15. Other Regulatory Information

EU	Reported in EINECS
USA	Reported in the EPA TSCA Inventory
Australia	Listed in AICS
Canada	Listed in DSL
China - China inventory - Hazardous Chemicals List	 Listed in IECSC The substance is included
Japan	Not subject to ENCS regulation
Korea - Industrial Safety and Health Act - Other requirements in domestic and other countries	Listed in the Korea Existing Chemicals Inventory (KECI), number KE-03605, Toxic chemical No.97-1-111, 1% or more in mixtures Controlled hazardous Substance Substance type: GP - Gas phase materials Harmful Substances Requiring Workplace Environment Monitoring Substance type: G - Gases Toxic Release Inventory (TRI) Chemicals Group: 2 (Reporting threshold of 10 tons per year) Clean Air Conservation Act - Air Pollutants
Mexico	Listed in the National Inventory of Chemical Substances (INSQ).
New Zealand Inventory	Listed in NZIoC
Philippines	Listed in PICCS
Taiwan	Listed (TCSI)
Vietnam	Listed
Thailand	Listed

16. Other information

References : Not available

Other special Consideration : Not available

MSDS creation date : 01st October 2013

Revision : 07

Last updated : 14th January 2022

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