Product Safety Assessment

*DOW™ Piperazine*


Select a Topic:

- Names
- Product Overview
- Manufacture of Product
- Product Description
- Product Uses
- Exposure Potential
- Health Information
- Environmental Information
- Physical Hazard Information
- Regulatory Information
- Additional Information
- References

**Names**

- CAS No. 110-85-0
- DOW™ piperazine
- Piperazidine
- 1,4-Piperazine
- Piperazidine
- 1,4-Diazacyclohexane
- Diethylenediamine
- Hexahydropyrazine (CAS No. 142-63-2)

**Product Overview**

- *DOW™* piperazine is the simplest cyclic member of the ethyleneamines family. Although it is a white crystalline flake material at room temperature, it is more often sold as a water white 64–69% solution in water to facilitate storage and handling. For further details, see Product Description.
- *DOW piperazine* is used in anthelmintics (a veterinary treatment for intestinal worms), pharmaceuticals, epoxy curing agents, polyamides, and as an intermediate in the production of certain polyurethane catalysts. For further details, see Product Uses.
- *DOW piperazine* is manufactured and used in closed systems. However, workplace exposure is possible during maintenance, transfer, or sampling operations. *DOW piperazine* is not sold for consumer use. However, it can be a component of veterinary and other products used by the public. For further details, see Exposure Potential.
- Piperazine liquid can cause severe burns to the eyes and skin or to the mouth and throat if swallowed. Exposure to liquid or vapor may result in an allergic skin or respiratory reaction. For further details, see Health Information.
- *DOW piperazine* is slightly toxic to fish. Its bioconcentration potential is low, and it biodegrades relatively slowly in the environment. It would not be expected to persist in the environment and would be removed by normal wastewater-treatment processes. For further details, see Environmental Information.
- *DOW piperazine* is a combustible liquid. It is stable under normal conditions of storage and use, but can react with a variety of chemicals. Organic-based absorbents should not be applied to spills. It can react with carbon dioxide in the air to form amine-carbamate salts, which can plug vent or relief lines. For further details, see Physical Hazard Information.
Manufacture of Product\(^6,7\)

- **Capacity** – Global annual production of ethyleneamines was estimated at 468,100 metric tons (approximately 1 billion pounds) in 2012. Dow produces ethyleneamines in the following locations: Freeport, Texas; Hahnville, Louisiana (St. Charles Operations); and Terneuzen, The Netherlands.

- **Process** – DOW™ piperazine is produced by reacting ethylene dichloride with an excess of ammonia under high pressure and moderate temperature. The resultant ethyleneamine hydrochloride solution is neutralized with caustic soda to form piperazine and other ethyleneamines, which are then separated and purified by distillation. Sodium chloride (salt) is formed as a by-product. The reaction sequence is shown below.

\[
\begin{align*}
\text{H}_2\text{C} & \text{Cl} \quad \text{[NH}_3\text{]} \quad \text{H}_2\text{C} \\
\text{H}_2\text{C} & \text{Cl} \quad \text{NH}_2\text{Cl} \\
\text{H}_2\text{C} & \text{NH}_2\text{Cl} + \text{Cl} \\
\text{H}_2\text{C} & \text{NH}_2\text{Cl} + \text{NaOH} \quad \text{H}_2\text{C} \\
\text{H}_2\text{C} & \text{NH}_2\text{Cl} + \text{NaCl} + \text{H}_2\text{O} \\
\end{align*}
\]

Dow also produces piperazine using the reductive amination process. In this process, monoethanolamine (MEA) is reacted with ammonia over a catalyst to produce several ethyleneamine products, including piperazine.

\[
\begin{align*}
\text{H}_2\text{C} & \text{OH} \quad \text{H}_2\text{C} \quad \text{NH}_2\text{H}_2\text{O} \\
\text{H}_2\text{C} & \text{NH}_2\text{H}_2\text{O} + \text{NH}_3 \quad [\text{catalyst}] \\
\text{H}_2\text{C} & \text{NH}_2\text{H}_2\text{O} + \text{Highers} \\
\end{align*}
\]

Product Description\(^1,2,4\)

DOW™ piperazine (C\(_4\)H\(_{10}\)N\(_2\)) is the simplest cyclic member of the ethyleneamines family. Although it is a white crystalline flake material at room temperature, Dow produces and markets it as a 68% solution in water (CAS No. 007732-18-5) to facilitate storage and handling. The solution is water white in color with a pH greater than 12 and an ammonia-like odor. Piperazine is also available from some producers as piperazine hexahydrate (44% solution, C\(_4\)H\(_{10}\)N\(_2\)•6H\(_2\)O, CAS No. 142-63-2).

Product Uses\(^2,8,9\)

DOW™ piperazine is used in combination with other materials to produce:

- **Agricultural and veterinary treatments** – as the active ingredient in many commercial anthelmintic products used for intestinal worms in livestock and pets

- **Chelating agents** – to form complexes with certain metal ions that prevent the ions from interfering with processing or to promote buffering, concentration, separation, or transport

- **Epoxy curing agents** – to enhance the performance and application of coatings, adhesives, laminates, castings, and grouts

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Revised: May 15, 2015

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Page 2 of 7
Product Safety Assessment: DOW™ Piperazine

- Marine protective coatings
- Polyamide resins – for use as varnishes, coatings, adhesives, and binders for printing inks
- Polyurethane catalyst – to produce polyurethane foams
- Pharmaceuticals – for analgesics, antidepressants, and drugs to treat impotence, angina, intestinal parasites, and motion sickness 25%
- Other miscellaneous products – such as cement grinding, corrosion inhibitors and more

Back to top

Exposure Potential

4,10,11,12 DOW™ piperazine is used in the production of industrial and consumer products. Based on the uses for this material, the public could be exposed through:

- **Workplace exposure** – Exposure can occur either in a piperazine manufacturing facility or in the various industrial or manufacturing facilities that use this material. It is produced, distributed, stored, and consumed in closed systems. Those working with piperazine in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Each manufacturing facility should have a thorough training program for employees and appropriate work processes, ventilation, and safety equipment in place to limit unnecessary exposure. See Health Information.

- **Consumer exposure to products containing DOW piperazine** – Dow does not sell piperazine for direct consumer use, but it can be a component of materials that may be handled by consumers. Always read the product information before use and follow the label/use instructions. Piperazine can be introduced to the environment by manure from animals treated with piperazine (anthelmintics) or as fertilizer on agricultural fields and grassland. See Health Information.

- **Environmental releases** – In the event of a spill, the focus is on containing the spill to prevent contamination of soil and surface or ground water. Eliminate all sources of ignition and ground and bond all containers and handling equipment. For small spills, piperazine should be absorbed with sand, clay, or dirt. Do not use organic absorbents such as peat moss, ground corn cobs, cellulose, or sawdust. If the material is hot or present as a spray or mist, use an approved air-purifying respirator with an organic vapor cartridge and a particulate prefilter or an air-supply full-face respirator. This material is considered slightly toxic to aquatic organisms on an acute basis. It would not be expected to persist in the environment and would be removed by normal wastewater-treatment processes. See Environmental, Health, and Physical Hazard Information.

- **Large release** – Industrial spills or releases are infrequent and generally contained. If a large spill does occur, the material should be captured, collected, and reprocessed or disposed of according to applicable governmental requirements. An approved air-purifying respirator with an organic vapor cartridge and a particulate prefilter is recommended for emergency work. Eliminate all sources of ignition immediately. Use only explosion-proof equipment; ground and bond all containers and handling equipment. See Environmental, Health, and Physical Hazard Information.

- **In case of fire** – Deny unnecessary entry into the area. Burning liquids may be extinguished by diluting with water, but use of a direct water stream may spread the fire. Use a water fog or fine spray, dry-chemical or carbon-dioxide extinguishers, or foam. Alcohol-resistant foams are preferred. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) and protective firefighting clothing and avoid contact with piperazine. If contact is likely, firefighters should wear chemical-resistant clothing in addition to SCBA gear. Follow emergency procedures carefully. See Environmental, Health, and Physical Hazard Information.

For more information, see the relevant Safety Data Sheet.
Health Information

Eye contact – Contact may cause severe irritation or chemical burns with corneal injury, which could result in permanent vision impairment.

Skin contact – Brief contact may result in burns. Symptoms may include pain, local redness, rash, and tissue damage. Prolonged contact may result in severe burns with pain, redness, swelling, and tissue damage. Even prolonged contact with skin is unlikely to result in absorption of harmful amounts. Skin contact may cause an allergic reaction, particularly for people who have had allergic reactions to similar materials in the past.

Inhalation – At room temperature, the vapor pressure of this material is too low to be an inhalation risk. However, if the material is heated or dispersed as a spray or mist, concentrations may be obtained that could cause respiratory irritation and asthma-like effects, such as coughing, difficult breathing, and a feeling of lightness in the chest. Occasionally, these difficulties can be life-threatening. Symptoms generally cease when the exposure is eliminated.

Ingestion – Piperazine has low toxicity when swallowed, but can cause burns to the mouth and throat. Swallowing or vomiting could result in aspiration of material into the lungs and consequent lung and tissue damage.

Other – Piperazine has not caused cancer in laboratory animals. It has caused birth defects and fetal death in laboratory animals, but only at doses toxic to the mother. In vitro and animal genetic toxicity studies have been negative.

For more information, see the relevant Safety Data Sheet.

Environmental Information

DOW™ piperazine is slightly toxic to fish. Its bioconcentration potential is low and it biodegrades relatively slowly in the environment. It would not be expected to persist in the environment and would be removed by normal wastewater-treatment processes.

For more information, see the relevant Safety Data Sheet.

Physical Hazard Information

DOW™ piperazine is stable under normal conditions of storage and use. Elevated temperatures can cause piperazine to decompose, with the possible release of ammonia, ethylenediamine, or other volatile amines. It can also react with carbon dioxide in the air to form amine-carbamate salts, which tend to plug vent and relief lines, compromising pressure-relief systems and introducing solid contaminants into the storage system.

Avoid contact with oxidizing materials, acids, halogenated hydrocarbons, nitrites, and metals such as brass, bronze, copper, and copper alloys. Avoid using organic absorbents such as ground corn cobs, sawdust, cellulose or peat moss.

For more information, see the relevant Safety Data Sheet.
Regulatory Information
Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of DOW™ piperazine. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant Safety Data Sheet, Technical Data Sheet, or Contact Us.

Additional Information
- Safety Data Sheet (http://www.dow.com/webapps/msds/msdssearch.aspx)
- Contact Us (http://www.dow.com/amines/contact.htm)

For more business information about DOW™ piperazine, visit the Dow Amines web site at www.dow.com/amines/prod/.

References
2. Piperazine, 68% Aqueous, Technical Data Sheet, The Dow Chemical Company, Form No. 108-01356
4. Piperazine 68% AQ Safety Data Sheet, The Dow Chemical Company

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*Back to top*