Product Safety Assessment

DOW™ Hexamethylene Diisocyanate (HDI)-Based Polymer Products

Product Safety Assessment documents are available at: www.dow.com/productsafety/finder/.

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Names
• CAS No, 28182-81-2
• CAS No. 822-06-0
• HDI
• Hexamethylene-1,6-diisocyanate
• Hexamethylene diisocyanate
• Hexamethylene diisocyanate, homopolymer
• DURELAST™ Isocyanates
• TRAFFIDECK™ Topcoats
• 1,6-Hexylene diisocyanate
• 1,6-Hexamethylene diisocyanate
• 1,6-Diisocyanatohexane
• 1,6-Hexanediol diisocyanate
• Hexane, 1,6-diisocyanato-
• Hexane 1,6-diisocyanate
• HYPERKOTE™ Isocyanates
• DOW™ HDI-based polymer products

Product Overview
• DOW™ hexamethylene diisocyanate (HDI)-based polymer products are formulations produced by Dow Polyurethane Systems and Dow Hyperlast, business units of The Dow Chemical Company ("Dow"). These products are colorless to yellow liquids with a mild odor. For further details, see Product Description.
• DOW HDI-based polymer products are used in industrial elastomer and coating applications where resistance to degradation by sunlight and weatherability are required. For further details, see Product Uses.
• DOW HDI-based polymer products are produced for industrial use only. Workers applying these materials can minimize the potential for exposure by carefully following application directions and wearing the proper safety equipment. Consumers may purchase goods that contain fully cured (hardened) HDI-based polymer products. For further details, see Exposure Potential.
• Eye contact may cause slight eye irritation or slight temporary corneal injury. Vapor or mist may cause eye irritation. Even brief skin contact may cause slight irritation with local redness. Prolonged skin contact may cause irritation with local redness. Excessive inhalation may cause severe irritation to upper respiratory tract (nose and throat) and lungs. Hexamethylene diisocyanate is a potent skin sensitizer. It may cause allergic respiratory response. Re-

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exposure to low concentrations may cause allergic respiratory reactions in sensitized individuals. For further details, see Health Information.

- DOW™ HDI-based polymer products inadvertently released to land or water will react with water to form insoluble polyureas. These materials are regarded as inert, as they are not degradable, unlikely to accumulate in the food chain, and are practically non-toxic to aquatic organisms. For further details, see Environmental Information.

- These products are stable under recommended storage conditions, which vary by product formulation. They can become unstable at temperatures above the recommended storage conditions. Avoid contact with water (moisture), acids, alcohols, amines, ammonia, bases, metal compounds, strong oxidizers, or moist organic absorbents. Avoid contact with metals such as zinc, brass, tin, or galvanized metals. For further details, see Physical Hazard Information.

Manufacture of Product

Capacity – In 2009, global production capacity of aliphatic and specialty diisocyanates, including hexamethylene diisocyanate (HDI) was 152,000 metric tonnes (335 million pounds). Dow purchases HDI to use in its HDI-based products. Dow prepolymerizes and formulates HDI in quantities sufficient to meet market demand. These products are marketed by Dow Formulated Systems and Dow Hyperlast, which comprise a global network of 26 system houses.

Process – DOW™ HDI homopolymer is formed by the reaction of hexamethylene diisocyanate with itself to give low molecular weight polymers, mainly dimers and trimers.

\[
\begin{align*}
\text{H}_{2}\text{N} & \text{C} = \text{O} - \text{NH}_2 - \text{CO} - \text{NH}_2 \\
\text{H} & \text{N} - \text{C} = \text{O} - \text{NH} - \text{C} = \text{O} - \text{NH} - \text{C} = \text{O}
\end{align*}
\]

\[x, \text{ with } x = \text{mainly 2 or 3}\]

Other DOW HDI-based prepolymer or variants are manufactured by carefully controlled reactions between hexamethylene diisocyanate and hydroxyl-containing materials.

Product Description

DOW™ hexamethylene diisocyanate homopolymer-based products are colorless to yellow liquids with a mild odor, and are formulated for specific uses. Dow markets these products under different trade names for different end-use applications. Dow trade names for these products and variants include, but are not limited to: DURELAST™ isocyanates, HYPERKOTE™ isocyanates, and TRAFFIDECK™ topcoats.

Product Uses

DOW™ hexamethylene diisocyanate-based products are used in industrial elastomer and coating applications where resistance to degradation by sunlight and weatherability are required. Modified hexamethylene diisocyanate-based prepolymer products are used to produce polyurethanes for the following applications:

- DURELAST™ isocyanates – furniture profiling and architectural finishing
- HYPERKOTE™ isocyanates – protective coatings for industrial and automotive use
- TRAFFIDECK™ topcoats – elastomeric waterproof layers for parking decks, bridges, and marine decks
Exposure Potential\textsuperscript{19,20}

DOW™ hexamethylene diisocyanate (HDI)-based products are used to produce industrial and consumer products. Based on these uses, those planning to work with, handle, or use them should review the relevant Safety Data Sheet and follow the precautions. Based on the uses for these products, the public could be exposed through:

- **Workplace exposure** – Exposure can potentially occur either in a manufacturing facility or in any industrial, commercial or manufacturing facilities that use these products. Those working with these products in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Because some of these products are used in spray lacquers and coatings, additional inhalation hazards may arise during application operations. Workers applying these materials can minimize the potential for exposure by carefully following application directions and wearing the proper safety equipment. Each manufacturing facility should have a thorough training program for employees and appropriate work processes, ventilation, and safety equipment in place to limit exposure. See Health Information.

- **Consumer exposure to products containing DOW HDI-based polymer products** – Dow does not sell these products for direct consumer use. They are intended for industrial use only. Based on product uses, consumers may purchase goods that have been manufactured using these products. However, the polyurethane will have fully cured (hardened) and the risk of exposure to hexamethylene diisocyanate would be very low by the time these goods reach the consumer. See Health Information.

- **Environmental releases** – DOW HDI-based polymer products are maintained in closed systems during manufacture and use, and as a result environmental releases are expected to be minimal. Because of their volatility and use in spray lacquers and coatings, some of these materials may be emitted into the air during those operations. Because these products are reactive with water, their manufacture, formulation, and packaging/transport must occur under strict exclusion of water and water vapor. As a result, water-based processing and cleaning operations are not employed and emissions to wastewater do not typically occur. Once introduced to water, these materials will readily react with the water to form solid polyurea polymers. These solid polyureas have high molecular weight, are resistant to biodegradation and hydrolysis, and have very low potential for introduction to and transport within groundwater. In the event of a spill, the focus is on containing the spill to prevent contamination of soil and surface or ground water. For small spills, the products should be absorbed with materials such as wet sand or sawdust. Collect recovered material in properly labeled, unsealed containers and dispose of it according to applicable government requirements. Eliminate all sources of ignition. See Environmental, Health, and Physical Hazard Information.

- **Large release** – Industrial spills or releases are infrequent and are generally contained. If a large spill does occur, the material should be absorbed with materials such as sawdust, dirt, vermiculite, sand, clay, cob grit, or Milsorb. Do not use absorbent materials such as cement powder as it may react and generate heat. Spilled material should be captured, collected, and reprocessed or disposed of according to applicable governmental requirements. Local emergency crews and trained personnel should be called to handle large spills. Only properly trained and equipped personnel should attempt to isolate or contain the spill. Positive pressure, self-contained breathing apparatus (SCBA) with an approved full-face mask 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 any unnecessary entry into the area. Keep people away. Stay upwind and out of low areas where fumes can accumulate. Water may be applied as a fine spray in large quantities when other extinguishing agents are not available. Use of a direct water stream may spread fire. Use water fog or fine spray, dry-chemical or carbon-dioxide extinguishers, or foam to fight the fire. Alcohol-resistant foams are preferred. Consider the...
use of unmanned hose holders or monitor nozzles. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) and protective firefighting clothing. Contain fire-water run-off if possible, as it may cause environmental damage. Follow emergency procedures carefully. The public should be warned of downwind vapor-explosion hazards. Keep vapors out of sewers. Immediately withdraw all personnel from the area in case of rising sounds from a venting safety device or discolorations of the container. See Environmental, Health, and Physical Hazard Information.

- **Unusual Fire and Explosion Hazards** – Some components of this product will burn in a fire situation. Product reacts with water. Reaction may produce heat and/or gasses. This reaction may be violent. Container may rupture from gas generation in a fire situation. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Dense smoke is produced when product burns. See Physical Hazard Information.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group or through the appropriate Polyurethanes Regional Call Center.

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**Health Information**

Health information for DOW™ hexamethylene diisocyanate-based polymer products is summarized on the relevant Safety Data Sheet. Health risks associated with individual products may vary based on their formulation or intended use. The Safety Data Sheet is the preferred source for specific health information. These materials may also contain minor components or additives that have additional health risks. An overview of health information for these products appears below.

**Eye contact** – Eye contact with these products may cause severe eye irritation or corneal injury. Vapor or mist may cause eye irritation experienced as mild discomfort and redness.

**Skin Contact** – Brief contact may cause slight skin irritation with local redness. Prolonged contact may cause skin irritation with local redness, but is unlikely to result in absorption of harmful amounts. Vapor may cause skin irritation or drying and flaking of the skin. Hexamethylene diisocyanate is a potent skin sensitizer. Severe skin rash/allergic skin reactions have been noted in people exposed to aerosols/vapors of heated material. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization.

**Inhalation** – Excessive exposure may cause severe irritation to the upper respiratory tract (nose and throat) and lungs. Decreased lung function has been associated with overexposure to isocyanates. Effects may be delayed. May cause allergic respiratory response. Re-exposure to extremely low isocyanate concentrations may cause allergic respiratory reactions in individuals already sensitized. Excessive exposure may aggravate pre-existing asthma and other respiratory disorders (e.g. emphysema, bronchitis, reactive airways dysfunction syndrome).

**Ingestion** – Very low toxicity if swallowed, but swallowing may cause gastrointestinal irritation, vomiting, and diarrhea. If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

**Other** – Some products have solvents that caused toxicity to the fetus, but did not cause birth defects. Some products have phthalate esters, which in animal studies have been toxic to the fetus at doses that proved toxic to the mothers and resulted in decreased weight and survival of offspring, but did not cause birth defects. Genetic toxicity studies have been negative.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group or through the appropriate Polyurethanes Regional Call Center.

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Environmental Information\textsuperscript{23,24}

Environmental risks associated with individual DOW™ hexamethylene diisocyanate-based polymer products vary by formulation and application. The Safety Data Sheet is the preferred source for specific information. All DOW™ HDI-based polymer products contain some unreacted hexamethylene diisocyanate. An overview of general environmental information for these products appears below.

Spilled HDI-based polymer products should be prevented from entering soil, ditches, sewers, waterways, and/or groundwater. HDI-based polymer products are insoluble in water. Upon contact with water or moist air, these products will react to form stable, insoluble polyurea solids. This reactivity dramatically limits the mobility of these products in the event of a spill (spills are localized and have only transient impact), and the products will tend to remain in, and react within, the environment to which they are released.

The polyurea solids formed by reaction of HDI-based polymer products with water have been shown to resist biodegradation and hydrolysis. HDI-based polymer products and their polyurea reaction products are not likely to accumulate in the food chain (their bioconcentration potential is low) due to their insolubility and high molecular weight, and are practically non-toxic to aquatic organisms on an acute basis.

Because released amounts of hexamethylene diisocyanate are low, and because any free hexamethylene diisocyanate emitted to water or soil will be readily converted into polyureas, the Organization for Economic Cooperation and Development (OECD) concluded that the assessment of HDI risk to the environment is of low priority for further work.\textsuperscript{25} Furthermore, Environment Canada has concluded that hexamethylene diisocyanate (HDI) did not meet its criteria for classification as persistent, bioaccumulative, or inherently toxic to aquatic organisms; and therefore the substance was not identified as a priority for further assessment under its Categorization and Screening of the Domestic Substances List (CSDSL) program.\textsuperscript{26}

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group or through the appropriate Polyurethanes Regional Call Center.

Physical Hazard Information\textsuperscript{27,28}

The physical hazard risks associated with individual products may vary by formulation and application. The Safety Data Sheet is the preferred source for specific information.

DOW™ HDI-based polymer products are stable under recommended storage conditions. However, they can decompose at elevated temperatures. Gas generated during decomposition can cause rapid pressure build-up in closed systems. These products can react with moisture, releasing carbon dioxide gas. The resulting pressure build-up can cause closed containers to rupture. Elevated temperatures can accelerate this reaction.

HDI-based polymer products can react with many materials and release heat. Avoid contact with acids, alcohols, amines, water, ammonia, bases, metal compounds, strong oxidizers, and moist air. Hazardous polymerization of HDI-based polymer products can occur. Polymerization can be catalyzed by strong bases and water. During a fire, smoke may contain hexamethylene diisocyanate in addition to other toxic and/or irritating compounds. Hazardous combustion products may include, but are not limited to nitrogen oxides, isocyanates, carbon monoxide, carbon dioxide, and hydrogen cyanide.
For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group or through the appropriate Polyurethanes Regional Call Center.

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Regulatory Information
Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of DOW™ HDI-based polymer products. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant Safety Data Sheet or Contact Us.

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Additional Information
- Safety Data Sheets (Dow Customer Information Group or Polyurethanes Regional Call Center)
- Contact Us (www.dow.com/pusystems/contact/index.htm)
- DURELAST™ 505 Isocyanate Material Safety Data Sheet, The Dow Chemical Company, June 14, 2010 (request from Dow Customer Information Group)
- TRAFFIDECK™ Topcoat ASP Part B Isocyanate Material Safety Data Sheet, The Dow Chemical Company, August 10, 2009 (request from Dow Customer Information Group)
- HYPERKOTE™ Sprayable Polyurethane Elastomer website (http://www.dow.com/hyperlast/app/index.htm)
- Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS) website (www.epa.gov/iris/subst/0638.htm)

For more business information about DOW™ isophorone diisocyanate products, visit the Dow Formulated Systems web site at www.dow.com/pusystems/index.htm or the Dow Hyperlast web site at www.dow.com/hyperlast/about/index.htm.

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