Product Safety Assessment

*DOW™ Modified Toluene Diisocyanate (TDI) Products*

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
- Toluene diisocyanate (TDI)
- TDI products
- TDI formulations
- TDI prepolymers
- TDI variants
- Modified TDI

CAS for modified TDI products include but are not limited to:
- CAS No. 584-84-9 2,4-Toluene diisocyanate
- CAS No. 91-08-7 2,6-Toluene diisocyanate
- CAS No. 26471-62-5 TDI 80/20
- CAS No. 57516-88-8 Ethoxylated, propoxylated glycerine, toluene diisocyanate polymer
- CAS No. 67700-43-0 Castor oil, polymer with TDI
- CAS No. 53426-99-6 Toluene diisocyanate, trimethylolpropane, polyethylene glycol polymer
- CAS No. 9052-50-0 Polypropylene glycol, ethoxylated, toluene diisocyanate polymer
- CAS No. 9057-91-4 Polypropylene glycol, toluene diisocyanate polymer
- CAS No. 9050-83-3 2,4-Diisocyanato-1-methylbenzene, polytetramethylene glycol polymer
- CAS No. 9017-01-0 Toluene diisocyanate, homopolymer

Dow tradenames for modified TDI products include but are not limited to:
- DIPRANE™ Prepolymers
- DURAMOULD™ Isocyanates
- HYPERLAST™ Prepolymers
- HYPOL™ Prepolymers
- SPECFLEX™ Isocyanates
- VORALUX™ Isocyanates
- VORAMER™ Isocyanates
- VORASTAR™ Isocyanates

### Product Overview

- This product assessment covers a group of products that share similar characteristics and properties. For information about a specific product, please refer to the particular product Safety Data Sheet (SDS). As used herein, the terms SDS and MSDS (i.e. Material Safety Data Sheet) are interchangeable.
- DOW™ modified TDI products are formulations produced by Dow Polyurethane Systems and Dow Hyperlast, businesses of The Dow Chemical Company. Toluene diisocyanate (TDI) is a reactive chemical. TDI’s isocyanate groups (−N=C=O) react with materials that have hydroxyl (−OH) groups to make polymers called polyurethanes. For this document, the term "modified TDI products" includes TDI-based prepolymer products as well as TDI-based formulations. Modified TDI products can also be called TDI variants. Modified TDI products always contain...
some free, unreacted TDI. Many of these products also contain other components such as methylene diphenyl diisocyanate (MDI), and additives such as flame retardants, surfactants, foam blowing agents, colorants, and plasticizers. For further details, see Manufacture of Product and Product Description.

- **Dow Polyurethane Systems** and **Dow Hyperlast** businesses sell modified TDI products for industrial manufacturing uses.² Modified TDI products are commonly used to manufacture automotive seating, furniture foam, polyurethane coatings, and elastomers. For further details, see Product Uses.

- There is a potential for workplace exposure to TDI in all industrial, commercial, or manufacturing settings where TDI is present. Each manufacturing facility should have a thorough training program for employees, appropriate work processes and safety equipment in place to limit unnecessary exposure. **Dow Polyurethane Systems** and **Dow Hyperlast** do not sell TDI for direct consumer use, but it is used as a raw material to make materials that consumers purchase. For further details, see Exposure Potential.

- TDI is a highly reactive hazardous chemical that has the potential to adversely affect or injure eyes, skin and respiratory tract if appropriate safe handling and use instructions are not followed, or if appropriate safe handling and use precautions are not employed. Modified TDI products may also contain additives that have additional health risks. Users of these materials should carefully review and follow the instructions and precautions provided in each product's Safety Data Sheet (SDS). For further details, see Health Information.

- TDI and modified TDI products react rapidly with water in the environment to form insoluble polyurea solids. These polyureas are generally not biodegradable and are resistant to hydrolysis (i.e. are inert). They are unlikely to accumulate in the food chain, and are slightly toxic to practically non-toxic to fish and other aquatic organisms. For further details, see Environmental Information.

- FOR EMERGENCY RESPONSE INSIDE THE UNITED STATES: Call CHEMTREC (1-800-424-9300) for advice on spilled TDI, fire, or other handling issues.³ TDI and modified TDI react with water to produce heat and carbon dioxide (CO₂) gas. For further details, see Physical Hazard Information.

### Manufacture of Product

- **Capacity** – In 2008, worldwide production capacity for TDI-based diisocyanates and polyisocyanates was 2.2 million metric tons (4.8 billion pounds). Dow is one of three major manufacturers of TDI in the U.S. and has global capacity to produce 160,000 metric tons (352 million pounds). Manufacturing locations include: Freeport, Texas, in the U.S.; and Camacari, Brazil.⁴ **DOW™ modified TDI products are produced by Dow Polyurethane Systems and Dow Hyperlast.** Dow’s Systems businesses operate a global network of 26 system houses.⁵

- **Process**⁶ – For information about the production of TDI, see Dow's TDI Product Safety Assessment. DOW modified TDI products and prepolymers are manufactured by carefully controlled reactions between TDI and hydroxyl-containing materials. If the number of hydroxyl groups is lower than the number of isocyanate groups, a modified TDI prepolymer is produced. Modified TDI prepolymers are also called TDI variants. A simplified reaction between TDI and a diol (a dihydroxy material) is shown on the next page.
Product Description

TDI has two different forms or isomers. TDI isomers have the same chemical formula C₉H₆N₂O₂, but the atoms are arranged differently. So, the term “TDI” represents the isomeric compounds along with mixtures of these isomers. The two commonly used isomers of toluene diisocyanate are 2,4-TDI and 2,6-TDI. Mixtures of 80% 2,4-TDI and 20% 2,6-TDI represent over 95% of the industrial usage.

DOW™ modified TDI products are manufactured and formulated according to manufacturer’s specifications and end-use applications. To tailor the product properties, components may be added to the reaction process. Additives may include methylenediphenyl diisocyanate (MDI), flame retardants, surfactants, plasticizers, foaming blowing agents, colorants, and other compounds. All modified TDI products contain some free or unreacted TDI in them. If MDI is added to the reaction process, some free or unreacted MDI may also be present.

DOW modified TDI products are colorless to brown liquids with pungent to mild odors depending on the nature of the polyol, the amount of free TDI and other components or additives that are present.

Dow tradenames for modified TDI products and prepolymers include but are not limited to:

- DIPRANE™ Prepolymers
- DURAMOULD™ Isocyanates
- HYPERLAST™ Prepolymers
- HYPOL™ Prepolymers
- SPECFLEX™ Isocyanates
- VORALUX™ Isocyanates
- VORAMER™ Isocyanates
- VORASTAR™ Isocyanates

Product Uses

TDI is commonly used to manufacture:

- **Flexible foams** – used for the fabrication of bedding, furniture, automotive seating, flexible packaging and carpet underlay; this is the largest market application for TDI
- **“Foamed-in-place” polyurethane plastics** – ranging from soft and sponge-like to hard and porous for use in furniture, packaging, insulation and boat building
- **Polyurethane coatings** – used on leather, wire, tank linings and masonry

* Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow
• **Elastomers** – used to produce adhesives, films and linings, and abrasive wheels and other mechanical items that require abrasion and solvent resistance
• **Rigid, “pour-in-place” foams** – for use in appliances, and, in smaller amounts, packaging
• **Urethane sealants** – used in construction applications
• **Cast elastomers** – for production of articles such as roller blade wheels

**DOW™** modified TDI products are used to produce polyurethanes for the following applications:
• **DIPRANE™ prepolymer**, **HYPERLAST™ prepolymer**, and **VORASTAR™ isocyanates** – adhesives, films and linings, wheels and other mechanical items (rollers, conveyors, etc.) that require abrasion and solvent resistance; also urethane sealants for construction applications and air filters
• **HYPOL™ prepolymer** – hydrophilic polyurethane foams, elastomers, coatings, adhesives or gels
• **HYPERLAST isocyanates** – coatings used on wire, tank linings and masonry
• **DURAMOULD™ prepolymer** – mold making
• **SPECFLEX™ isocyanates** – automotive trims such as pillars, acoustical insulation/foam, armrests, consoles, energy management foam, headrests/seat cushioning, steering wheels, and a variety of instrument panel components such as air bag doors and knee bolsters
• **VORALUX™ isocyanates** – high-resilience foam for furniture and pillars
• **VORAMER™ isocyanates** – binders in a variety of recycling applications, bonding together different kinds of shredded materials such as rubber, flexible polyurethane foams, ethylene-vinyl acetate, cork and gravel

**Back to top**

**Exposure Potential**

**DOW™** modified TDI products are used in the production of industrial and consumer products. Based on the uses for these products, the public could be exposed through:
• **Workplace exposure** – There is a potential for workplace exposure to TDI in all industrial, commercial, or manufacturing settings where TDI is present. Such exposure may be harmful if appropriate safe handling and use instructions are not followed, or if appropriate safe handling and use precautions are not employed. Each manufacturing facility should have a thorough training program for employees, appropriate work processes and safety equipment in place to limit unnecessary exposure. For a general overview of TDI health information, see Health Information.
• **Consumer exposure to products containing DOW modified TDI products** – Modified TDI products produced by Dow Polyurethane Systems and Dow Hyperlast are for industrial use only. Based on product uses, consumers may purchase goods that have been manufactured with modified TDI products. However, by the time these goods reach the consumer, the polyurethane has fully cured (hardened) and risk of TDI exposure is very low. See Health Information.
• **Environmental releases** – Environmental emissions of DOW modified TDI products are unlikely to result from their manufacture and/or intended use due to the use of closed systems and stringent process controls. Contact of these products with air, water, or soil results in reactions which degrade product purity and performance. All spills and leaks should be immediately contained to prevent contamination of soil, surface or ground water. The area should be ventilated; open all doors and windows. To avoid inhaling vapors, workers should wear approved, positive-pressure self-contained breathing apparatus (SCBA). For small spills, modified TDI products should be absorbed with materials such as: vermiculite, dirt, sand, or clay. Do NOT use absorbent materials such as cement powder as it may generate heat. Shovel the absorbent into a properly labeled open container and cover but do not seal. Consult the **VORANATE T-80 Toluene Diisocyanates Safe Handling & Storage Guide** or relevant Safety Data Sheet for neutralization information and more information about the products.
protective equipment and procedures. See Environmental, Health and Physical Hazard Information.

- **Large release** – Industrial spills or releases are infrequent and are generally contained. In the event of a large spill, local emergency response services should be contacted immediately, and a state of emergency should be declared for the affected area. Contingency arrangements should be discussed with local emergency response services, such as police and fire units, in advance of actual emergency situations. A written emergency plan for large spill control should be in place with periodic drill practices scheduled before actual emergency situations occur. A positive-pressure, self-contained breathing apparatus (SCBA) with a full-face mask approved by NIOSH is recommended for emergency work. Follow emergency plan guidelines and procedures carefully. FOR EMERGENCY RESPONSE INSIDE THE UNITED STATES: Call CHEMTREC (1-800-424-9300) for first response advice for handling TDI. CHEMTREC will make contact with the manufacturer. The material should be neutralized, captured, collected and re-processed, or disposed of according to applicable governmental requirements. Consult the VORANATE T-80 Toluene Diisocyanates Safe Handling & Storage Guide and relevant Safety Data Sheet. See Environmental, Health and Physical Hazard Information.

- **In case of fire** – Keep people away. Isolate fire and deny unnecessary entry. Stay upwind and out of low areas where gases can accumulate. Water is not recommended but may be applied in large quantities as a fine spray when other extinguishing agents are not available. Use water fog or fine spray, dry-chemical or carbon-dioxide extinguishers, or foam to fight the fire. Alcohol-resistant foams are preferred. A direct water stream may spread the fire. Consider the use of unmanned hose holders or monitor nozzles. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) with an approved full-face mask and protective firefighting clothing. Contain fire water run-off if possible. Fire water run-off, if not contained, may cause environmental damage. Follow emergency procedures carefully.

For more information, see the relevant Safety Data Sheet.

**Health Information**

Health information for specific DOW™ modified TDI products is summarized on the relevant Safety Data Sheet. A potential user of TDI who plans to work with, handle, or use TDI, or who anticipates coming in contact with TDI in a workplace setting should carefully review the information provided in the Material Safety Data Sheet (MSDS) specific to the particular TDI product involved and should carefully follow the instructions and precautions provided in that MSDS. It is important to note that health risks associated with individual products may vary based on their formulation or intended use. All modified TDI products contain some free or unreacted TDI. They may also contain free MDI and minor components or additives that have additional health risks. The Safety Data Sheet is the preferred source for specific health information. An overview of TDI health information appears below.

**Ingestion** – TDI has low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however swallowing larger amounts may cause injury. Use good personal hygiene practices. Do not consume or store food in the work area. Wash hands before smoking or eating.

**Inhalation** – Easily attainable vapor concentrations of TDI may cause serious adverse effects, even death. Excessive exposure to TDI may cause severe irritation of the upper respiratory tract and lungs, fluid in the lungs, permanent decrease of lung function, neurologic disorders, cholinesterase depression, and gastrointestinal distress. Atmospheric levels should be
maintained below exposure guideline. TDI may cause allergic respiratory response. Re-exposure to extremely low isocyanate concentrations may cause allergic respiratory reactions in individuals already sensitized. Asthma-like symptoms may include coughing, difficult breathing and a feeling of tightness in the chest. Occasionally, breathing difficulties may be life threatening. Effects may be delayed.

**Skin Contact** – Skin contact may cause an allergic skin reaction. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization.

**Eye Contact** – TDI may cause severe eye irritation and moderate corneal injury. Vapor may cause eye irritation experienced as mild discomfort and redness.

**Other** – TDI is listed as an anticipated or possible carcinogen by NTP (National Toxicology Program) and IARC (International Agency for Research on Cancer). An oral study in which high doses of TDI were reported to cause cancer in animals has been found to contain numerous deficiencies which compromise the validity of the study. TDI did not cause cancer in laboratory animals exposed by inhalation, the most likely route of exposure. TDI did not cause birth defects in laboratory animals. Slight effects were observed in the fetus but only at doses which caused toxic effects to the mother. In animal studies, TDI has been shown not to interfere with reproduction.

For more information, see the relevant Safety Data Sheet.

### Environmental Information

Spilled TDI and modified TDI products should be prevented from contacting soil and entering into ditches, sewers, waterways and/or groundwater. Environmental risks associated with individual products vary by formulation and application. The Safety Data Sheet is the preferred source for specific information. All modified TDI products contain some free or unreacted TDI. An overview of general environmental information appears below.

TDI and modified TDI products are insoluble in water and have low vapor pressure. Upon contact with water or moist air, the products will react to form stable, insoluble polyurea solids. This reaction and the low vapor pressure dramatically limit the mobility of these materials in the event of a spill (spills are localized and have only transient impact). The products will tend to remain in and react with the environment into which they are released.

Due to their low vapor pressures and use in closed systems, vapors of TDI and modified TDI products are unlikely to be emitted to the atmosphere. In the event that vapors are released, TDI is expected to degrade rapidly by indirect atmospheric photolysis.

The polyureas formed by reaction of TDI and modified TDI products with water have been shown to be resistant to biodegradation and hydrolysis. However, they are practically non-toxic and will not accumulate in the food chain. They are thus regarded as “inert” in the environment. Trace amounts of minor, water-soluble products of the reaction of pure TDI substances with water have been shown to be slightly to practically non-toxic to a number of aquatic species in both short- and long-term tests.

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

It is important to note that the physical hazard risks associated with individual products may vary by formulation and application. The Safety Data Sheet is the preferred source for specific physical hazard information. All modified TDI products contain some free or unreacted TDI. An overview of TDI physical hazard information appears below.

TDI is stable under recommended storage conditions. However, it can decompose at elevated temperatures. Gas generated during decomposition can cause pressure in closed systems. Pressure build-up can be rapid. TDI 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.

TDI can react with many materials and release heat. Avoid contact with acids, alcohols, amines, water, ammonia, bases, metal compounds, strong oxidizers, and moist air.

During a fire, smoke may contain TDI in addition to 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.

Hazardous polymerization of TDI can occur. Polymerization can be catalyzed by strong bases and water.¹⁹

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™ modified TDI 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.

Additional Information

- Safety Data Sheet (request from the Dow Customer Information Group http://www.dow.com/assistance/dowcig.htm)
- Contact Us (http://www.dow.com/polyurethane/contact/index.htm)
• U.S. Environmental Protection Agency Integrated Risk Information System (IRIS) website – 2,4-/2,6-Toluene diisocyanate mixture (TDI) (CASRN 26471-62-5): 
  (http://www.epa.gov/ncea/iris/subst/0503.htm)

For more business information about DOW™ TDI and modified TDI products, visit:
• The Dow Polyurethane Systems website at www.pusystems.com
• The Dow Hyperlast website at www.dowhyperlast.com
• Dow’s Polyurethanes web site at www.dow.com/polyurethane

References

5  DOW Polyurethanes website: About Dow Polyurethanes:  
   http://www.dow.com/polyurethane/about/about.htm.  
8  DOW Polyurethanes website: About Dow Polyurethanes:  
   http://www.dow.com/polyurethane/about/about.htm.  
13 Video, Safe Handling of Toluene Diisocyanate (TDI), PRIMEDIA Workplace Learning, Inc., 1999.  

Back to top
NOTICES:

As part of its 2015 Sustainability Goals, Dow has committed to make publicly available safety assessments for its products globally. This product safety assessment is intended to give general information about the chemical (or categories of chemicals) addressed. It is not intended to provide an in-depth discussion of health and safety information. Additional information is available through the relevant Safety Data Sheet, which should be consulted before use of the chemical. This product safety assessment does not replace required communication documents such as the Safety Data Sheet.

The information herein is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Dow be responsible for damages of any nature whatsoever resulting from the use of or reliance upon the information herein or the product to which that information refers.

Nothing contained herein is to be construed as a recommendation to use any product, process, equipment or formulation in conflict with any patent, and Dow makes no representation or warranty, express or implied, that the use thereof will not infringe any patent.

NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

Dow makes no commitment to update or correct any information that appears on the Internet or on its World-Wide Web server. The information contained in this document is supplemental to the Internet Disclaimer, [http://www.dow.com/homepage/disclosure.html](http://www.dow.com/homepage/disclosure.html)

Back to top

Form No. 233-00617-MM-1009

©™® Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow