

Sources of Exposure

Toxicokinetics and Biomonitoring

Biomarkers/Environmental Levels

General Populations

- Exposure to toluene diisocyanate (TDI) and methylenediphenyl diisocyanate (MDI) can occur from inhaling air where uncured (unreacted) products such as adhesives, sealants, coatings, paints, craft materials, and insulating foams are present.
- It is unlikely that consumers would be exposed to TDI and MDI from cured products, such as cushions.
- Exposure of the general population to TDI or MDI through food or water is unlikely.

Occupational Populations

- TDI and MDI are most frequently detected in occupational settings, mainly by inhalation of aerosol and vapor (TDI only).
- Diisocyanates are used in the production of polyurethane foam during foaming, casting, spraying, and other processes. Exposure may also occur after production when the polymer is processed.
- Thermal degradation of polyurethane foam during processes such as heat cutting of foam blocks, flame lamination with textiles, and welding, cutting, or grinding of polyurethane-coated metal, can also release diisocyanates into the air.
- Dermal exposure may occur by contact with uncured polyurethane products.

Toxicokinetics

- TDI and MDI in air can be absorbed through the lungs, but quantitative data in humans are not available.
- TDI can also be absorbed through the gastrointestinal tract; there are no data for MDI.
- Small amounts of both chemicals can enter the body through the skin.
- TDI and MDI combine readily with macromolecules, including hemoglobin, albumin, and others. They are widely distributed throughout the body.
- TDI and MDI primarily leave the body in the feces; a small amount also leaves the body in the urine.

NHANES Biomonitoring

- There are no data regarding levels of TDI and MDI in the general population.

Biomarkers

- Urine and plasma levels of breakdown products of TDI and MDI such as toluene diamine and methylenedianiline can indicate exposure to TDI or MDI, but are not specific.
- TDI or MDI bound to albumin in plasma indicates specific exposure to diisocyanates.

Environmental Levels

Air

- Nationwide estimated average concentration from point sources were 1.4×10^{-5} mg/m³ (TDI) and 7.3×10^{-5} mg/m³ (MDI) in 2011.

Sediment and Soil

- There are no recent monitoring data for soil levels of TDI or MDI in the United States.

Water

- There are no recent monitoring data for water levels of TDI or MDI in the United States.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2018. Toxicological Profile for Toluene Diisocyanate and Methylenediphenyl Diisocyanate. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™
for

Toluene Diisocyanate
Methylenediphenyl
Diisocyanate

$C_9H_6N_2O_2$ $C_{15}H_{10}N_2O_2$

CAS# 26471-62-5 101-68-8

June 2018

U.S. Department of Health and
Human Services
Public Health Service
Agency for Toxic Substances
and Disease Registry
www.atsdr.cdc.gov



Chemical and Physical Information

Routes of Exposure

Relevance to Public Health (Health Effects)

TDI is a Liquid and MDI is a Solid

- TDI and MDI are synthetic substances.
- TDI is a clear, colorless to pale yellow liquid. MDI is a light yellow crystalline solid.
- TDI and MDI have several forms or isomers. The two most common TDI isomers are 2,4-TDI and 2,6-TDI. The most common isomer of MDI is 4,4'-MDI.
- TDI and MDI are used to make many household products.
- TDI and MDI combine with other chemicals to produce various polyurethanes. Some of the products made with these polyurethanes include foam for furniture cushions and carpet padding, spray foam, and waterproof sealants.

- Inhalation – Minor route of exposure for the general population. Important route of exposure for workers who manufacture cured (unreactive) and uncured polyurethane products.
- Oral – Unlikely route of exposure for the general population because TDI and MDI are not found in food or water.
- Dermal – Possible exposure route for the general population if handling products containing uncured diisocyanates. Important route of exposure for workers who manufacture cured and uncured polyurethane products.

TDI and MDI in the Environment

- TDI and MDI can be released into the air, water, and soil at places where they are produced or used.
- TDI and MDI are extremely reactive chemicals and are not likely to accumulate in the environment.
- Half the TDI and MDI in air will disappear in less than 1 day. TDI is expected to only exist as a vapor. MDI is expected to exist in both vapor and particulate phases.
- In soil, TDI and MDI will rapidly undergo hydrolysis and are therefore not likely to volatilize, leach, or adsorb to soil.
- TDI and MDI rapidly react with water to form other compounds. The half-life of TDI and MDI is a few minutes to a few hours.
- TDI and MDI will not bioaccumulate in the food chain.

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- An acute-duration (≤ 14 days) inhalation MRL of 0.00001 ppm was derived for TDI.
- No intermediate-duration (15–364 days) inhalation MRL was derived for TDI.
- A chronic-duration (≥ 365 days) inhalation MRL of 0.000003 ppm was derived for TDI.
- No acute- (≤ 14 days) or intermediate- (15–364 days) duration inhalation MRLs were derived for MDI.
- A chronic-duration (≥ 365 days) inhalation MRL of 0.001 mg/m³ was derived for polymeric MDI.

Oral

- No acute- (≤ 14 days), intermediate- (15–364 days), or chronic- (≥ 365 days) duration oral MRLs were derived for TDI or MDI.

Health Effects

- Respiratory effects, including a decrease in lung function, have been reported in workers exposed to TDI or MDI.

- Some workers can become sensitized to TDI and MDI and may experience adverse effects at much lower exposure levels than the concentrations that may affect non-sensitized individuals.
- Asthma and symptoms of asthma, such as wheezing and shortness of breath, have been observed in some individuals who are particularly sensitive to the toxicity of TDI and MDI.
- In animals, chronic oral exposure of TDI increased incidences of soft tissue, pancreatic, mammary gland, and liver tumors. Chronic inhalation exposure of rats to MDI led to increased lung cancer.
- The National Institute of Environmental Health Sciences (NIEHS) considers TDI as reasonably anticipated to be a human carcinogen. The U.S. Environmental Protection Agency (EPA) has not classified the carcinogenicity of TDI. EPA notes that the carcinogenicity of MDI cannot be determined, but there is suggestive evidence that raises concern for carcinogenic effects. The International Agency for Research on Cancer (IARC) has classified TDI as possibly carcinogenic to humans (Group 2B) and determined that 4,4'-MDI is not classifiable (Group 3).

Children's Health

- There is no information on the effects of TDI or MDI in children.
- It is not known if children are more sensitive to TDI or MDI exposure than adults.