

# Correcting the Record on IARC's Flawed Classification of Toluene Diisocyanate (TDI)

## Toluene Diisocyanate (TDI) Case Study

In 1986, the International Agency for Research on Cancer (IARC) classified Toluene Diisocyanate (TDI) as "possibly carcinogenic to humans" [Group 2B].

### OVERVIEW

This listing is flawed and is unsubstantiated by credible scientific evidence. TDI's case study is an example of IARC's failure to consider a chemical's primary route of exposure in humans, which for TDI is via inhalation or dermal contact. Further, TDI is used primarily for applications of flexible polyurethane foam, such as furniture, pillows and footwear; finished consumer products made of polyurethane foam are considered by the U.S. Environmental Protection Agency (EPA) not to expose consumers to TDI. IARC's cancer classification does not reflect a reliable assessment of actual risk presented by a substance based on exposure under realistic circumstances.

The IARC carcinogenicity classification for TDI is based solely on one conceptually and technically flawed study performed over 30 years ago by the National Toxicology Program (NTP). NTP administered a bolus dose of TDI by oral gavage directly into the acidic environment of the rodent stomach – an implausible real-world exposure route in humans – because TDI was too reactive/ unstable to be mixed with feed.

Chronic exposure studies in animals and epidemiological studies in humans have demonstrated that the relevant modes of physiological exposures to TDI do not result in carcinogenicity. IARC had used flawed science as justification for its listing of TDI as a human carcinogen.

### WHAT IS TDI?

Toluene Diisocyanate, or TDI, is part of the family of diisocyanates, which makes many of the products that we rely upon every day safer, tougher and more comfortable. TDI in particular is used primarily for flexible polyurethane foam applications including furniture, bedding and carpet underlay, as well as for packaging applications. TDI is also used in the manufacture of coatings, adhesives, sealants and elastomers. In transportation applications, TDI helps produce lighter automobile parts, saving weight and leading to improvements in fuel efficiency, and thus energy conservation.



## CAN TDI BE USED SAFELY?

Manufacturers are committed to the safe use and handling of TDI. The industry must comply with a variety of federal, state and local regulations before the product reaches the marketplace. Diisocyanates have been in use since the 1940s and are well-studied chemistries with a robust database of scientific information. Extensive safety precautions enforced by government mandates are undertaken by the diisocyanates industry to protect worker and consumer health and to safeguard local communities and the environment.

Workplaces are required to follow the OSHA Permissible Exposure Limit of 20 parts per billion (ppb) or face penalties. At the recommended workplace concentrations, generally no short- or long-term health effects from TDI would be expected. However, if levels were to exceed recommended workplace exposure limits, diisocyanates could be strongly irritating to workers' eyes, nose, throat, skin and lungs. If diisocyanate exposures were to occur well above 20 ppb, evidence indicates that respiratory sensitization and asthma represent the greatest potential health concerns. Nevertheless, TDI can be used safely with the use of appropriate workplace practices, including use of personal protective equipment, engineering controls and a medical surveillance program.



Most polyurethane products made with TDI – such as furniture, mattresses, pillows, car seating and footwear – are completely cured and therefore considered inert before they are sold, according to EPA's 2011 TDI Action Plan. This means that TDI is no longer present in its original form in the fully cured product, as it was transformed during the chemical reaction into the finished polyurethane product.

On this basis, finished consumer products made of polyurethane foam are considered by EPA not to expose consumers to TDI. Therefore, TDI could not be transferred to a consumer via the air or by direct contact with the product. Once the foam has been manufactured or incorporated into furniture for sale to the consumer, "free TDI" or "unreacted TDI" is no longer available. A study was done to assess the potential health risk from exposure to TDI for people who sleep on a polyurethane mattress. The tests results indicated no measurable emission or migration of TDI from the polyurethane samples tested (Vangronsveld et al., 2013). The risk assessment concluded that sleeping on a polyurethane foam mattress for a lifetime does not pose TDI-related health risks to consumers (Arnold et al., 2012).

## UNNECESSARY PUBLIC CONCERN

Despite the fact that a more complete review of the science supports the conclusion that TDI is not a human carcinogen, IARC's 30-year-old misclassification of TDI is reflected in the current listings of several health departments and agencies, creating unnecessary public concern.

IARC's TDI carcinogenicity listing is based on a flawed 1986 NTP study. First, NTP study investigators administered TDI that had been stored in corn oil for up to one week; during this time TDI reaction products (e.g., toluene diamine, TDA) began to appear at progressively higher levels (Appendix I of 1986 NTP study; Seel et al., 1999). Second, NTP compounded this error by administering test material via a feeding tube directly into the acidic environment of a rodent stomach. It is well known that the low pH of the stomach, found nowhere else in the body, favors the transformation of TDI to TDA, (see discussion by Prueitt et al., 2013).

While the NTP investigators qualitatively recognized the similar tumor spectrum varieties produced by both TDI and TDA in rodents, they dismissed the NTP study flaws with their belief that transformations of TDI to TDA would also occur in the more pH-neutral environments found elsewhere in the rodent body (Dieter et al., 1990). However, subsequent studies have shown this not to be the case; TDA has not been detected under normal exposure conditions such as inhalation (Timchalk et al., 1994) and dermal contact (Rosenberg and Savolainen, 1985).

## CONCLUSION

The IARC carcinogenicity classification for TDI is based on an unrealistic exposure scenario and is not reflective of scientific consensus. IARC's cancer classifications often depart from scientific consensus and provide inaccurate information, leading to unnecessary concern among both consumers and policymakers who protect public health.



Learn more about diisocyanates, the incredible chemical building block, by watching the video [here](https://www.americanchemistry.com/DII-Chemical-Building-Block-Video.html): <https://www.americanchemistry.com/DII-Chemical-Building-Block-Video.html>

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