Guidance for the Selection of Protective Clothing for TDI Users

Table of Contents

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Purpose

The purpose of this document is to provide useful guidance for selecting the appropriate personal protective equipment (PPE) for working with toluene diisocyanate (TDI)[1] and to analyze the performance characteristics of gloves, coveralls, splash suits, and other protective garments commonly used when working with TDI. TDI is colorless to pale yellow liquid at room temperature with a sharp, pungent odor.

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Health and Safety Information

During the handling, processing, and application of TDI, contact with vapor, liquid, or mist may cause adverse health effects to the skin, eyes, and respiratory system. Inhalation of TDI vapors or mists at concentrations above the occupational exposure limit (e.g., ACGIH-TLV or OSHA-PEL) can irritate the respiratory system (nose, throat, lungs) causing runny nose, sore throat, coughing, chest discomfort, shortness of breath or reduced lung function. Persons with a pre-existing condition, non-specific bronchial hyper-reactivity, can respond to airborne concentrations below the threshold limit value (TLV) or permissible exposure limit (PEL) with similar symptoms as well as an asthma attack or asthma-like symptoms. As a result of previous repeated overexposures (above the TLV or PEL) or a single large dose, certain individuals may develop sensitization to diisocyanates (asthma or asthma-like symptoms) that may cause them to react to a later exposure to diisocyanates at levels well below the TLV or PEL.

Direct skin contact with TDI may cause irritation with symptoms of reddening, itching, and swelling. Persons previously sensitized can experience allergic skin reaction with symptoms of reddening, itching, swelling, and rash. Prolonged contact can cause reddening, swelling, rash, and, in some cases, skin sensitization. Animal tests and other research indicate that skin contact with TDI can play a role in causing isocyanate sensitization and respiratory reaction.

Engineering controls (e.g., local exhaust ventilation) and sound workplace practices can be the first line of defense against potential exposure to TDI, and guidelines have been established by OSHA to help individuals avoid overexposure and adverse health effects[1]. It is important that employees wear PPE recommended for their specific job functions to prevent direct skin/eye contact with liquid TDI or inhalation of TDI vapors/mist.

Eye Protection and Respiratory Protection

In addition to the gloves and garments analyzed later in this bulletin, individuals working with TDI products need to consider the use of appropriate eye, face, and respiratory protection.

Eye Protection

In situations where there is splash potential (e.g., when directly handling liquid product), workers wear goggles and, depending upon the extent of potential contact, a faceshield. These situations may include line-breaking (transfer hose disconnect), transfer of material using a drum pump, etc.

TDI may irritate the eyes and can be difficult to remove, so prevention is very important.

Respiratory Protection

At normal room temperatures (i.e., 70 °F), airborne concentrations of TDI can quickly exceed the TLV or PEL. Therefore, wear respiratory protection in work situations with inadequate ventilation. The type of respiratory protection selected must comply with the requirements set forth in OSHA's Respiratory Protection Standard (29 CFR 1910.134). The use of air purifying (cartridge) respirators (APRs) is acceptable in certain situations as part of a comprehensive respiratory protection program[2]. An organic vapor (OV) cartridge may be used with the APR where the concentration of TDI in air can be documented, it is verified that the sorbent capacity will prevent breakthrough, and where the protection factor will not be exceeded. A cartridge change out schedule is required to be part of the respiratory protection program by OSHA. When concentrations of TDI exceed or are likely to exceed the protection afforded by a cartridge respirator (e.g., emergency situations or identified high exposure potential activities), a supplied air respirator (SAR) is necessary under OSHA's standard.

[1] For details, see CPI Guidance Document AX202, *Working With TDI: Things You Should Know,* available at www.polyurethane.org.
[2] For more details on the use of air purifying respirators under the OSHA Standard, please refer to Guidance Document AX 246, CPI *Model Respiratory Protection program for Compliance with the Occupational Safety Health Administration Respiratory Protection Standard 29 CFR §1910.134,* available at www.polyurethane.org.

Selecting Protective Clothing

Understand and adhere to safe handling practices for TDI and other chemicals that pose potential health hazards. This may include wearing eye protection, respiratory protection, gloves, boots and coveralls or lab aprons. For individuals who work with TDI, appropriate protective clothing is essential for the prevention of skin exposures.

When selecting protective clothing consider the following factors:

- *Chemical Resistance of Glove or Garment:* To be effective, the protective clothing should resist permeation by the chemical or chemicals being handled. The use of disposable gloves and clothing is often preferred, because proper decontamination of reusable items can be difficult.

- *Specific Job Functions:* The nature of the job being performed will greatly influence the selection and features of protective clothing. For example, analyzing foam samples in a laboratory may require light-duty gloves (<10 mils in thickness) that are flexible and preserve manual dexterity; on the other hand, a maintenance project, such as repairing a pump line, may require thicker gloves that are rugged and durable.

- When the manual dexterity requirements of some jobs require the use of thin, form-fitting gloves that offer limited protection times, *change the gloves with sufficient frequency*.

- *Potential for Exposure:* The degree of exposure for individual job functions dictates the degree of personal protection required, and the appropriate clothing for the job. For instance, work conducted in a laboratory environment, where the potential for exposure to the skin and eyes is limited, may need gloves, eye protection, and a lab apron or lab coat. On the other hand, a project that presents a greater risk of acute exposure to the skin and eyes, such as loading and unloading tank cars, may need to use hooded coveralls, boots, and more substantial gloves to ensure adequate protection.

- *Duration of Exposure:* The length of time that an individual is working with or handling TDI will influences the type of protective clothing selected. When working with TDI for extended time periods, protective clothing that offers the greatest level of chemical resistance is appropriate.

In addition to these factors, individual work habits, industrial hygiene practices and pre-existing workplace procedures and controls will influence decisions made when selecting protective clothing.

Research Approach

The International Isocyanate Institute (III) sponsored a study in which Texas Research Institute evaluated materials from more than 50 items of chemical protective clothing—35 gloves of 10 different materials and 17 suits of 14 different materials—to determine the degree of resistance to permeation offered by each garment.

The III research measured the length of time it took TDI to penetrate the protective clothing material under conditions of continuous contact and complete surface coverage with TDI. However, this research did not address how solvents affect glove or garment protection for TDI users.

Discussion of Tables

The tables are organized by glove or garment type, and within each category, are arranged in descending order according to the protection time provided[3]. Research included the trade name, manufacturer, thickness, and durability of each item.

Table 1—Protective Gloves for Toluene Diisocyanate (TDI) by type (light, medium, heavy duty); within type by protection time

Glove Type	Material	Manufacture	Trade Name	Model #	Thickness (mil)	Durability*	Dexterity*	TDI Protection Time (hours)
Heavy Duty	Neoprene	Ansell Edmont	Neox	9-924	72.0	High	Low	6.0
Heavy Duty	Neoprene	Ansell Edmont	Scorpio	8-352	38.5	Medium	Medium	4.7
Heavy Duty	PVC	Jomac	--	8122	57.0	High	Low	1.5
Heavy Duty	PVC	Best	Black Night	7712R	51.0	High	Low	1.5
Heavy Duty	PVC	Jomac	--	7112	39.0	High	Low	1.3
Heavy Duty	Nitrile	Best	Ultraflex	21R	42.0	High	Medium	0.75
Medium Duty	Butyl	North	--	B-161	7.5	Medium	Medium	>8.0
Medium Duty	Laminated PE/EVAL	North	Silver Shield	(7094)	4.0	Low	High	>8.0
Medium Duty	Nitrile	Perfect Fit	Stansolve	AF-18	18.5	Medium	Medium	>8.0
Medium Duty	Butyl	North	--	B-131	11.5	Low	High	>8.0
Medium Duty	Laminated PE/EVAL	Safety 4 (Ansell Edmont)	4H	(87400)	2.0	Low	Medium	>8.0
Medium Duty	Nitrile	Ansell Edmont	Solvex	37-155	12.5	Medium	Medium	>8.0
Medium Duty	Natural Rubber	Ansell Edmont	Canners & Handlers	392	20.0	Medium	Medium	0.5
Medium Duty	Natural Rubber	Marigold	--	326Y	18.0	Low	High	0.33
Medium Duty	Natural Rubber	Perfect Fit	--	L118	11.0			<0.25
Light Duty	Nitrile	Best	N-Dex	7005	4.0	Low	High	0.5
Light Duty	Natural Rubber	Best	Dermathin	1005	7.0	Low	High	<0.25
Light Duty	PVC	Perfect Fit	Pylox	212 (V-10)	9.0	Low	High	<0.25
Light Duty	Natural Rubber	Johnson & Johnson	Microtouch	(1)	5.0	Low	High	<0.25
Light Duty	Nitrile	Best	N-Dex	9005	6.0	Low	High	<0.25
Light Duty	Polyurethane	Ansell Edmont	Poly-D	35-112	1.5	Low	High	<0.25

*Based on subjective evaluation – information provided as a guideline only.

Table 2—Body Protective Clothing for Toluene Diisocyanate (TDI) by garment type; within type, by protection time

Clothing Type	Material	Manufacturer	Trade Name	Model #	Thickness (mil)	Durability*	TDI Protection Time (hours)
Coverall (Disposable)	Laminated	Kappler	Chemrel	-	9.0	High	>8.0
Coverall (Disposable)	Laminated	Kappler	CPFII	-	15.0	High	>8.0
Coverall (Disposable)	Nonwoven	DuPont	Tychem SL	-	7.0	Medium	>8.0
Coverall (Disposable)	Laminated	Keppler	Chemtuff	-	10.0	High	>8.0
Coverall (Disposable)	Laminated	DuPont	Barricade	-	14.0	High	>8.0
Coverall (Disposable)	Nonwoven	DuPont	Tychem QC	-	6.0	Low	0.25
Coverall (Disposable)	Nonwoven	Kimberly Clark	Hazard Guard I	-	20.0	Low	<0.25
Coverall (Disposable)	Nonwoven	Kimberly Clark	Hazard Guard I	-	13.0	Low	<0.25
Coverall (Disposable)	Nonwoven	DuPont	Tyvek	-	5.0	Low	<0.25
Splash Suit (Level B)	Laminated	Kappler	Responder	-	14.0	High	>8.0
Splash Suit	Neoprene	Rainfair	Chem Tech II	1000-8552	7.0	High	1.33
Splash Suit	PVC	River City	Wizard	300J	11.0	High	<0.25
Splash Suit	Polyurethane	Rainfair	Medallion	1100-1937	8.0	Low	<0.25
Splash Suit	PVC	Neese Rubber Co.	Universal	35	10.0	High	<0.25

*Based on subjective evaluation – information provided as a guideline only.

The TDI protection times presented in the tables are the times required for TDI to penetrate the chemical protective glove or garment material, and are the maximum suggested use times. Change gloves and garments with sufficient frequency to avoid exceeding the listed protection times. For

[3] Protection times refer only to the time required for TDI to penetrate the garment and do not address permeation by solvents or TDI solvent combinations.

example, if a job requires the use of thin, flexible gloves with a 30- minute protection time, then the wearer should change gloves within 30 minutes of initial contact with TDI.

Some solvents, such as methylene chloride, are expected to penetrate quickly (<0.25 hour) the protective garments listed in the tables. If solvents penetrate the protective garments, TDI may be carried through the garment with the solvent. Therefore, it is important to assess not only the degree to which protective garments prevent TDI permeation, but also the degree to which they prevent permeation by any solvents used.

Although a large number of chemical protective gloves and garments were tested, this technical bulletin by III was not intended to be a comprehensive review of every piece of protective clothing currently available. Other gloves and garments not included in this study may provide equivalent protection.

When working with TDI, users may consult their protective clothing suppliers and TDI manufacturers to keep informed of new protective clothing developments.

Additional Information

For additional information on TDI protective clothing, safe handling, and disposal, consult the following sources:
Guidelines for the Selection of Chemical Protective Clothing, American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Building D-7, Cincinnati, Ohio 45211-4438.

Technical Data Sheets (TDS) and current Safety Data Sheets (SDS) for toluene diisocyanate (TDI) available from the supplier.

Working With TDI: Things You Should Know (AX202), Center for the Polyurethanes Industry.

Health Effects of Diisocyanates: Guidelines for Medical Personnel (AX150), Center for the Polyurethanes Industry.

Guidelines for the Responsible Disposal of Containers and Wastes from Polyurethane Raw Materials Processing (AX151), Center for the Polyurethanes Industry.

Model Respiratory Protection Program for Compliance with the Occupational Safety and Health Administration Respiratory Protection Standard 29 CFR§ 1910.134

Legal

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