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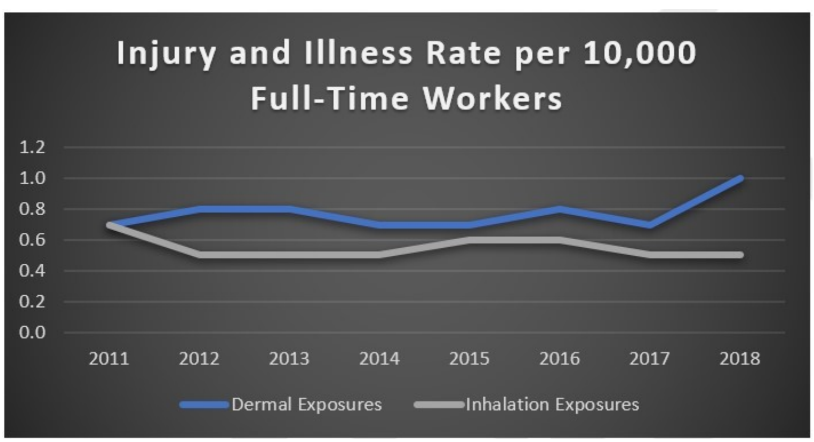
Synergist® Solutions: Are Those the Right Gloves?

How Hazardous Chemical Assessment Informs Optimal Glove Choice

By Lucinette Alvarado

What is the largest organ in the human body that accounts for greater than sixteen percent of our body mass? Skin is the right answer! With its many essential functions including water preservation, shock absorption, protection, waterproofing, vitamin D synthesis, temperature control, and lubrication—to name a few—any skin injury or illness can have severe impact. The U.S. Bureau of Labor Statistics defines skin diseases or disorders as illnesses involving the worker's skin that are caused by work exposure to different agents.

Skin exposure in the workplace is a significant problem in the United States. Both the number of cases and the rate of skin disorders exceed the recordable respiratory conditions. Over the past eight years, there has been an increase in dermal injury and illness cases compared to respiratory related occurrences per 10,000 full-time workers, while the rate of inhalation exposures has decreased.



Source: www.bls.gov/data

One main reason for these trends may be that exposure assessment in the workplace usually starts with air sampling for vapors and particulates, and results in implementation of controls for those airborne hazards. From the data shown, it is important to assess dermal exposures as significant contributors alongside inhalation exposures.

How Do Chemicals "Go Dermal"?

Our skin has three layers: the epidermis, dermis, and hypodermis. The epidermis is the outermost layer of skin (0−40 micrometers thick) that provides a waterproof barrier and creates our skin tone. The dermis, which is located beneath the epidermis, contains tough connective tissue, hair follicles, and sweat glands. The hypodermis is the deeper subcutaneous tissue and is made of fat and connective tissue.

A worker's skin can be exposed to and affected by each or any combination of the following hazards:

- Biological agents, which include parasites, microorganisms, plants, and other animal materials
- Physical agents such as extreme temperatures (hot or cold) and radiation (ultraviolet/solar radiation)
- Mechanical trauma including friction, pressure, abrasions, lacerations, and contusions (scrapes, cuts, and bruises)
- Chemical agents, which are the main cause of occupational skin diseases and disorders. These agents are divided into two types: primary irritants and sensitizers. Primary or direct irritants act directly on the skin through chemical reactions. Sensitizers may not cause immediate skin reactions, but repeated exposure can result in allergic response.

Hazardous chemical agents can affect the skin through direct contact with contaminated surfaces, deposition of aerosols, immersion, or splashes. These chemicals penetrate the skin by dermal absorption, the transport of a chemical from the outer surface of the skin both into the skin and into the body. According to the NIOSH Skin Exposures & Effects web page, studies show that absorption of chemicals through the skin can occur without being noticed by the worker, and in some cases, may represent the most significant exposure pathway.

There are three ways that chemicals can be absorbed through the skin:

- Intercellular lipid pathway where the chemicals can penetrate through these lipid-filled intercellular spaces via diffusion.
- Transcellular permeation where the chemical directly diffuses into the skin.
- Through the appendages, which is the diffusion of chemicals into and through the skin appendages (i.e. hair follicles and glands). This pathway is usually insignificant because the surface area of the appendages is very small compared to the total skin area. However, very slowly permeating chemicals often diffuse into the skin in this manner during the initial stage of absorption.

Many chemicals commonly used in the workplace, such as pesticides and organic solvents, could potentially result in systemic toxicity if they penetrate through the skin. These chemicals enter the blood stream and cause health problems away from the site of entry. This is one of the main reasons workers wear gloves when handling chemicals. However, the big question is: Are those the right gloves?

What Glove Standards, Guidance, and Assessment Tools are Available?

In many cases, workers are not wearing suitable glove protection. This may be due to a lack of knowledge of how to select the correct type of gloves based on the chemicals used and the type of task performed. Glove manufacturers provide guidelines on what type of gloves should be used for specific chemicals; however, at times, this is not enough data for selection. Often, additional information on individual work practices and other work environment factors can play an important role in choosing the optimal gloves.

Research has been performed to calculate the permeation rate of gloves. This is the rate at which a specific chemical or chemical type passes through a particular glove material. This testing involves absorption on the glove surface, the diffusion of the chemical through the material, and desorption on the inside surface of the glove. Standards exist that provide guidance on how to test the chemical permeation of gloves, such as the European Committee for Standardization (CEN) EN 16523-1:2015+A1:2018: *Determination of Material Resistance to Permeation by Chemicals*. This British standard provides specific instructions to determine:

- The glove's resistance to permeation by chemicals
- Permeation by liquid material under conditions of continuous contact
- Resistance to penetration
- Resistance to degradation by chemicals among related protocols

Another CEN standard, EN ISO 374-1:2016+A1:2018, is based on three test methods: penetration test (EN 374-2:2019), permeation test (EN 16523-1:2015, which replaces standard EN 374-3), and degradation test (EN 374-4:2019). Glove manufacturers apply these standards to classify gloves as follows:

Glove Type	Requirement	Marking (example)
Type A	30 minutes (level 2) against minimum 6 test chemicals	EN ISO 374-1:2016/Type A JKLMNO
Type B	30 minutes (level 2) against minimum 3 test chemicals	EN ISO 374-1:2016/Type B JKL
Type C	10 minutes (level 1) against minimum 1 test chemical	EN ISO 374-1:2016/Type C

The EN ISO 374-1:2016 standard referenced in the table above presents a list of chemicals that were tested with respective code letters. The code letters indicate the chemicals with which the gloves were challenged.

These standards provide great guidance for manufacturers to test the gloves; however, the specific protection must be determined as part of a personal protective equipment (PPE) assessment within the actual work processes and the specific application conditions.

A tool to consider for use during the risk assessment for glove selection is PERMEA-TEC sensor pads. These small adhesive bandage-style pads can be used to evaluate the effectiveness of gloves and other PPE in actual field use conditions. The sensor pads provide direct-reading colorimetric detection through a micro-encapsulated indicator system. The normal sensitivity range is 0.5 to 5 µg. The sensor pads can detect aromatic and aliphatic amines, aromatic and aliphatic isocyanates, acids, bases, phenols, and solvents. Each of these chemical groups is represented by a specific color change; for example, aromatic and aliphatic isocyanates turn the pad a characteristic red/orange color. To assess solvents, the PERMEA-TEC Solvent model contains both an indicator and a charcoal pad that can be sent to a laboratory for gas chromatography (GC) analysis.

Reacted sensor pad for aromatic and aliphatic isocyanates.

PERMEA-TEC sensor pads have been used in several studies related to exposure assessment and other field studies, especially in the polyurethane industry. Based on the data generated by these studies, the sensor pads have been shown to be a good tool to determine correct glove selection in the workplace, detect potential chemical permeation, and perform an overall exposure assessment.

Answering the Ultimate Question: Are Those the *Right* Gloves?

Determining the right gloves requires a multi-faceted approach and should at least include a combination of:

- Information gained by a hazardous chemical assessment
- The standards and tools discussed in this article
- Significant information on individual work practices

Armed with data generated by this approach, we can accurately assess dermal exposures in the workplace and identify the right gloves to use.

It is important to understand that dermal exposures can be as significant as inhalation exposures, if not more so in some cases. For the health and safety of workers, we need to remember to look comprehensively at all exposure routes—how they relate to each other and the actual work process and specific application conditions.

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