

## Selecting a Glove for Protection against Chemicals: Step 4 Finding Chemical Resistance Data

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Finding chemical resistance data for a specific chemical against different glove choices can be challenging. Most do not know that there are excellent sources of information available online that can even help address exposures to complex mixtures, pharmaceuticals, and pesticides. Much of this information can be found in the scientific literature, which is becoming more readily available online. The primary focus here is on permeation data, but both permeation and degradation information will be discussed in more detail later.

### Permeation data

In a nut shell, permeation data provide an indication of 1) “how soon” the chemical will pass through the glove and expose the user and 2) “how fast” the chemical will travel through the glove. The “how soon” is the breakthrough time (BT). The “how fast” is the permeation rate (PR), also known as the steady-state permeation rate (SSPR). Both are important when selecting an appropriate glove material and/or brand for chemical protection. The goal in this article is to help find the information. Later we will discuss how to apply the findings.

There are two main forms of permeation data available:

1. General chemical resistance data; and
2. Permeation test data.

### General Chemical Resistance Data

General chemical resistance data are useful when selecting which type of polymer would work best and there are several guidelines available to aid in the selection process. Some manufacturers will provide permeation data, but generally not for disposable gloves. These guidelines, which were discussed earlier, include the following:

#### General chemical resistance charts for different glove and/or clothing materials

Source	Title / Link
Forsberg and Mansdorf (2007)	Quick Selection Guide to Chemical Protective Clothing, 5 <sup>th</sup> Edition (Wiley) <a href="http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470146818.html">http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470146818.html</a>
NIOSH (online)	Recommendations for Chemical Protective Clothing: A Companion to the NIOSH Pocket Guide to Chemical Hazards: Database <a href="http://www.cdc.gov/niosh/ncpc/">http://www.cdc.gov/niosh/ncpc/</a>

### Glove manufacturer chemical resistance charts for different products (partial list)

Manufacturer	Link
Ammex	<a href="http://www.ammex.com/ChemRes.php">http://www.ammex.com/ChemRes.php</a>
Ansell	<a href="http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf">http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf</a>
North	<a href="http://www.northsafety.com/ClientFormsImages/NorthSafety/CorpSite/E8D15F2E-1F59-454F-B8F0-147FA2B9D81D.pdf">http://www.northsafety.com/ClientFormsImages/NorthSafety/CorpSite/E8D15F2E-1F59-454F-B8F0-147FA2B9D81D.pdf</a>
Microflex	<a href="http://www.microflex.com/Products/~/_media/Files/Literature/Microflex%20Chemical%20Resistance%20Guide.ashx">http://www.microflex.com/Products/~/_media/Files/Literature/Microflex%20Chemical%20Resistance%20Guide.ashx</a>
ShowaBest	<a href="http://www.chemrest.com/chemrest/hazards">http://www.chemrest.com/chemrest/hazards</a>

However, the major drawbacks with relying on general guidelines are that:

1. Most of the guidelines are for thicker chemical resistant gloves, not for disposable gloves; and
2. We must often assume all gloves of a similar type provide the same level of protection, which just is not the case. Glove brands are not manufactured with the same formulation and perform differently than each other.

Therefore, when chemical resistance is of importance it may be wise to select a thicker chemical resistant glove material that has been well tested. The other option is to search the literature for permeation data specific to your chemical hazard. It can prove worthwhile to search the scientific literature for permeation data, as many research studies are available online.

### Finding Permeation Data in the Scientific and Professional Literature

This section presents some useful online sources for finding chemical specific permeation test data. The primary resources include:

Pubmed (at <http://www.ncbi.nlm.nih.gov/pubmed/>)

This is a U.S. National Library of Medicine and National Institutes of Health website with over 20 million research abstracts and/or articles from the biomedical fields, which includes glove permeation studies. The abstracts are free and often provide key results (e.g., BT, PR or SSPR information). Often there are links to the full article (free of charge), especially for federally funded research.

Tip #1: Search by chemical name with the added words “glove permeation”

Tip #2: Search by chemical name with the added words “glove breakthrough”

Tip #3: Search by chemical name with the added words “ASTM F739”

Tip #4: Search by your specific application (e.g., paint stripping) with the added word “glove”

Tip #5: Full text articles, when available, are often indicated in the top right corner of the webpage.

Hazardous Substance Data Bank (HSDB) (at <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>)

This is a U.S. National Library of Medicine data bank with specific reference to sources and research studies on chemical hazards.

Tip: Search by the chemical name and then navigate the left-hand tool bar for “*Chemical Safety & Handling*” and then “*Protective Equipment and Clothing.*” Recommendations for respirators are also included in the HSDB.

Google Scholar (at <http://scholar.google.com/>)

This search engine is extremely useful in finding glove permeation data available online.

Tip #1: Disable or uncheck the “include patents” and “Legal documents” before starting.

Tip #2: Search for articles using terminology similar to that for Pubmed (above).

Tip #3: Limit your search to more recent years to find gloves in current production.

Microsoft’s Academic Search (at <http://academic.research.microsoft.com/>)

This search engine is useful in finding glove permeation data available online.

Tip: Search for articles using terminology similar to that for Pubmed (above).

### **Try this to test and perfect your search skills – Search for permeation data on “mineral oil”**

Mineral oil is a common component of metal working fluids, lubricants, pharmaceuticals, cosmetics, and pesticides. There are many industries that will run into the issue of providing general protection against mineral oil, while having to maintain dexterity through the use of a disposable glove material. The toxicity of mineral oils is low (it is often in skin moisturizers), but continual skin contact may result in irritation and or development of skin infections. The mineral oil can block skin pores, which can then become infected resulting in acne-like infections. It is important to protect workers exposed to large amounts of mineral oil in the workplace.

Using the general guidelines presented earlier, here are some results you should get:

- Forsberg and Mansdorf (2007): Thicker (> 0.3mm) nitrile gloves are recommended.
- NIOSH: Under “Oil mist (mineral)” it states “Contact the manufacturer for recommendations”
- Ammex: Nitrile recommended
- Ansell: Not listed
- Microflex: Not listed
- North: Not listed
- ShowaBest: No gloves listed

Obviously, these results do not give us confidence that a thinner, disposable exam glove will provide adequate protection against inadvertent contact with mineral oil. There is some indication that nitrile should be a likely choice. The next step is to look to the scientific literature for possible permeation data with disposable materials, especially nitrile. Here is a summary of the results you should have found in your search:

- Pubmed: A search of “glove permeation mineral oil” resulted in two articles dealing with permeation of metal working fluids through various disposable and chemically resistant gloves. The Kimberly-Clark Safeskin disposable nitrile glove tested provided a breakthrough time over 30 minutes ( $0.7 \pm 0.3$  h) and the lowest permeation rate of the various disposable gloves tested (Xu and Que Hee, 2006; Xu and Que Hee, 2007). This simple search was an immediate success.
- HSDB: No specific recommendations
- Google Scholar: A search of “glove permeation mineral oil” resulted in the same two articles from Pubmed, plus about 6,000 other articles. The findings were narrowed to reveal four additional articles of interest on the subject by adding the terms “nitrile disposable astm f739” to the search and limiting the results to “Since 2008.” Two of the articles dealt with degradation of nitrile and latex gloves exposed to mineral oils and/or metal working fluids. You should have found that Google Scholar worked extremely well, but found too many articles and required some work to narrow down the focus.
- Microsoft Academic Search: a search of “glove permeation mineral oil” resulted in one study evaluating swelling of disposable glove materials exposed to different metal working fluids. Disposable nitrile gloves were least affected (Xu and Que Hee, 2008).

These combined results indicate that disposable nitrile gloves are a likely best choice among disposable glove products such as latex, vinyl and neoprene. Permeation data was available for one disposable glove product (i.e., Kimberly-Clark Safeskin gloves), which means we have at least one disposable nitrile glove that is a viable choice for worker protection up to about 30 minutes. These results are much more convincing than the general guidelines and manufacturer guidelines reviewed earlier.

Try it with a chemical in your workplace and see what you get. It is not foolproof, but it never hurts to search the available literature.

#### References and Additional Reading:

1. Anna, Ed. (2003) *Chemical Protective Clothing, Second Edition*. AIHA Press, Falls Church, VA.
2. Boman, Estlander, Wahlberg, and Maibach, Eds. (2005) *Protective Gloves for Occupational Use, Second Edition*. CRC Press, Boca Raton, FL.
3. Forsberg and Mansdorf (2007) *Quick Selection Guide to Chemical Protective Clothing, Fifth Edition*. Wiley-Interscience, Hoboken, NJ.
4. Hazardous Substance Data Bank (2012) Accessed online December 22, 2012 at <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>.
5. Occupational Safety and Health Administration (OSHA) *Chemical Protective Clothing in OSHA Technical Manual*. Accessed online (July 30, 2012) at [http://www.osha.gov/dts/osta/otm/otm\\_viii/otm\\_viii\\_1.html](http://www.osha.gov/dts/osta/otm/otm_viii/otm_viii_1.html).

6. Plog, Niland, and Quinlan, Eds. (2001) *Fundamentals of Industrial Hygiene*, Fifth Edition. National Safety Council, Itasca, IL.
7. Xu and Que Hee (2006) Permeation of a straight oil metalworking fluid through a disposable and a chemically protective nitrile glove. *Journal of Hazardous Materials*, Volume 137, pages 709-15.
8. Xu and Que Hee (2007) Permeation of a straight oil metalworking fluid through disposable nitrile, chloroprene, vinyl, and latex gloves. *Journal of Hazardous Materials*, Volume 147, pages 923-9.
9. Xu and Que Hee (2008) Swelling of Four Glove Materials Challenged by Six Metalworking Fluids. *Archives of Environmental Contamination and Toxicology*, Volume 54, pages 1-8.