Ansell

PARAMETERS INFLUENCING SELECTION OF PPE AGAINST HAZARDOUS SUBSTANCES

SAFETY BRIEFING

INTRODUCTION

Hazardous substances interact with chemical PPE in 3 key ways:

Penetration, **Degradation** and **Permeation.**

Each of these 3 aspects can individually, or as part of a combination, effect the efficacy of protection and must be taken into account when asking questions such as:

"Can I reuse the PPE after it has been exposed to a chemical?"

or

"For how long should I wear an item of PPE?"

Getting answers to these questions can often be daunting given the level of data required to make an informed decision and the implications of specifying incorrect PPE. The aspects discussed within this paper aim to shed light on each of these processes and how the data available from Ansell may provide aid in the selection of correct PPE.

> "A CHEMICAL PPE'S ABILITY TO PROTECT IS DEPENDENT ON A NUMBER OF VARIABLES, OF WHICH TIME CONSTRAINTS ARE ONLY ONE OF THEM."

CHEMICAL PROPERTIES

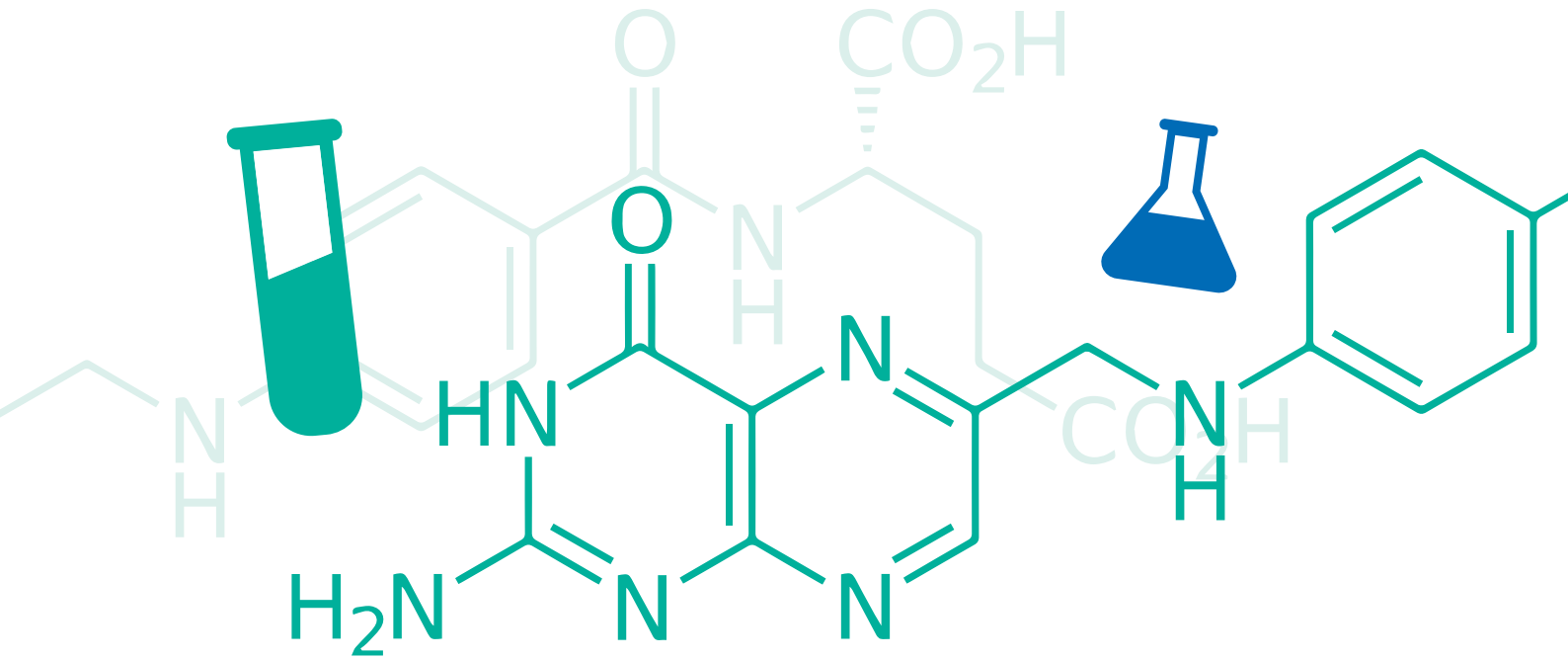
> **"CHEMICAL PPE MATERIALS WILL PERFORM DIFFERENTLY DEPENDING ON THE NATURE AND HANDLING OF CHEMICALS."**

The performance level of a piece of chemical PPE will depend on the inherent properties of the type of material used.

THIS COULD BE DIFFERENT TYPES OF RUBBER POLYMERS OR THE PLASTIC LAMINATE MAKE-UP OF THE PRODUCT.

Each piece of PPE will perform differently depending on the chemical in use, as each chemical group will have unique interactions with the barrier materials. A piece of PPE which has poor performance against one chemical could have excellent performance against another.

Your end use application may handle a large number of chemicals, most often in mixtures, which could all have different interactions with each other and the materials. Therefore, PPE selection and risk assessment for wear time must take all of this into account.



CAN I REUSE MY PPE?

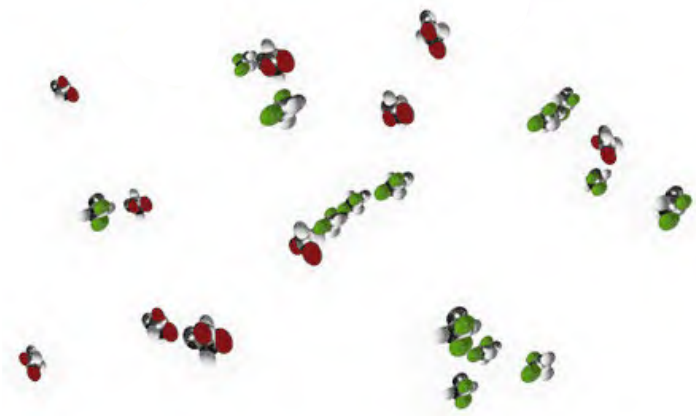
The decision to reuse chemical PPE can often be difficult due to a number of factors.

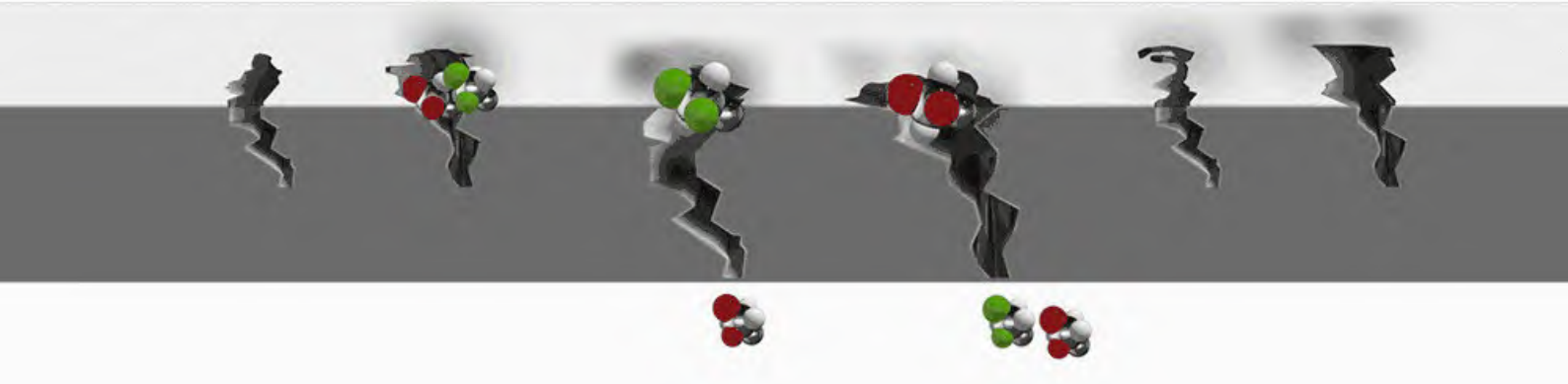
One consideration is protection from chemicals penetrating the barrier material. This is where chemical moves through open channels in the PPE material through tears, punctures or cracks. These may form from damage of long wear times, chemical contact or misuse of PPE. The PPE material can also be inherently porous, which is why correct initial selection is important.

> **"WHEN INSPECTING THE PPE BEFORE USE, OR DURING YOUR WORKING DAY, IF YOU OBSERVE DAMAGE OF ANY FORM OR FEEL ANY LIQUID INSIDE, IT IS RECOMMENDED THAT THE PPE IS REPLACED IMMEDIATELY."**

PENETRATION

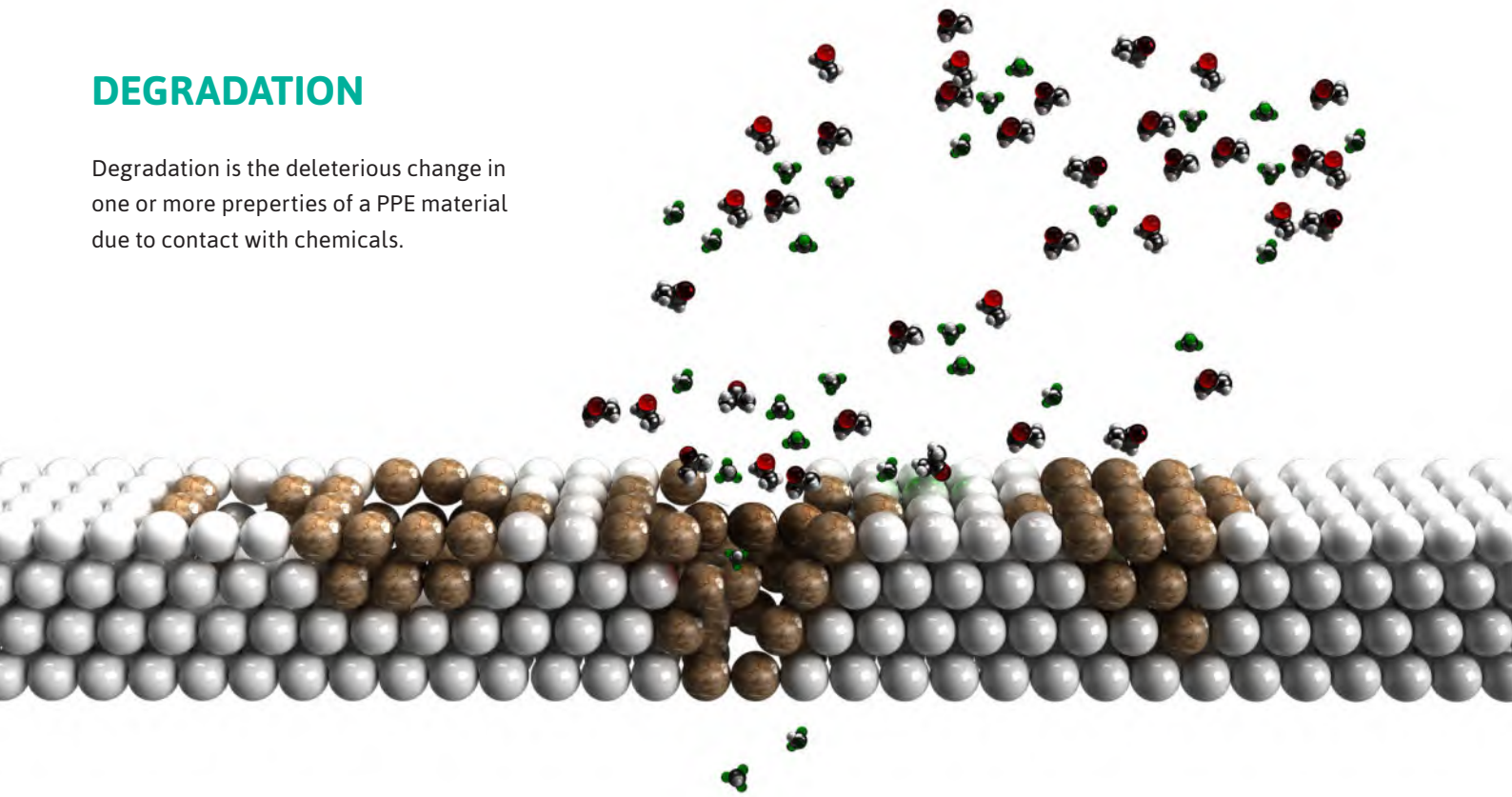
Chemicals can enter PPE materials through pores, cracks, or tears as a result of physical or chemical deterioration. This is referred to as 'Penetration'.





DEGRADATION

Degradation is the deleterious change in one or more preperties of a PPE material due to contact with chemicals.



DISCOLOURATION ELONGATION BURNED HARDENED & CRACKED

Chemicals can degrade materials in many ways, all of which can potentially affect the PPEs protective properties. Any damage created from degradation could potentially increase harmful substance exposure.

> **"DISCOLOURED, ELONGATED, BURNED, SWELLING, STICKINESS AND HARDENED & CRACKED PPES ARE EXAMPLES OF DEGRADATION AND IF ANY OF THESE ARE PRESENT, IT IS RECOMMENDED THAT THE PPE IS REPLACED IMMEDIATELY."**

WHAT IF THERE IS NO VISUAL CHANGE?

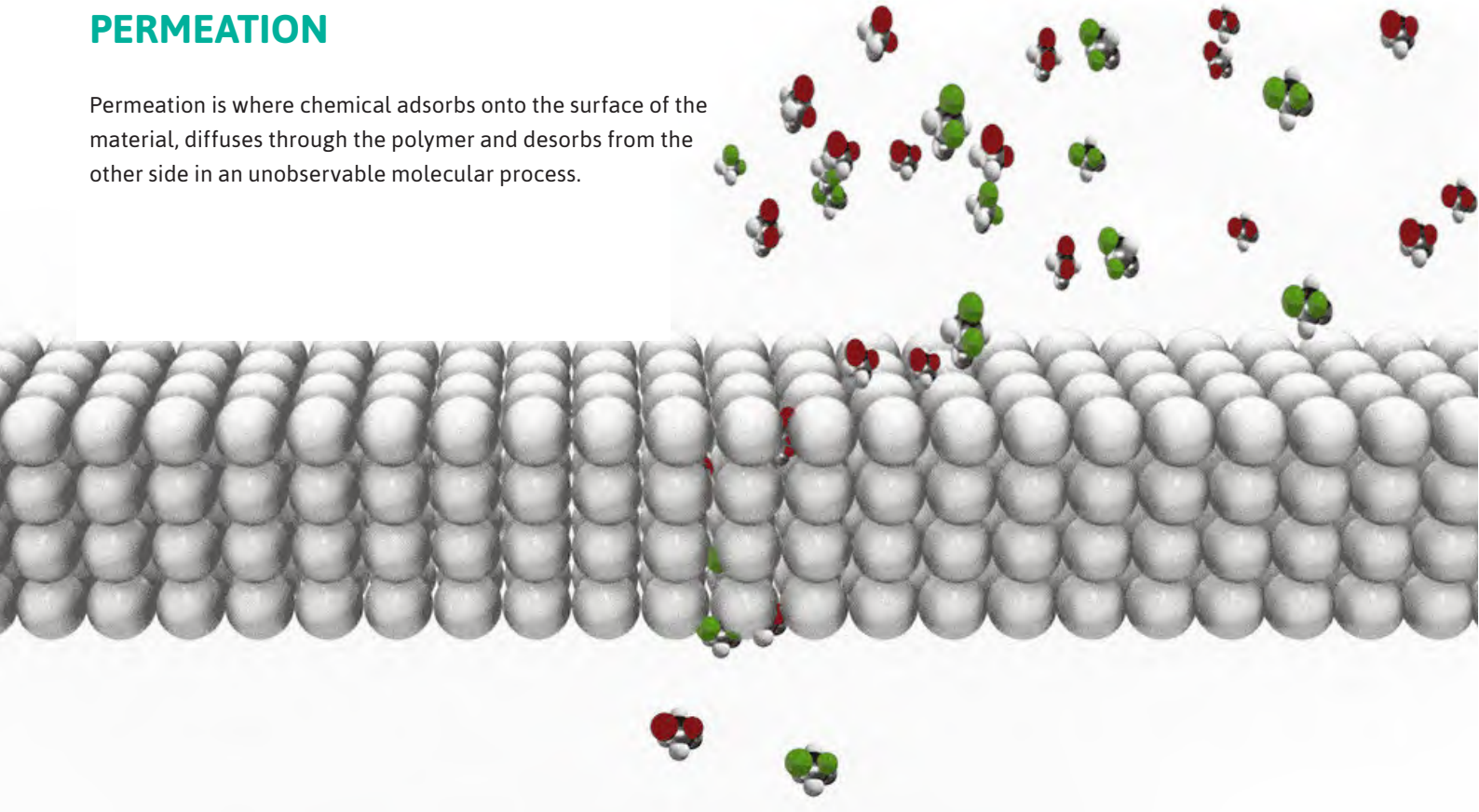
If the PPE has already been in contact with a chemical, it is possible that the used PPE can no longer provide the same protection compared to its first-time use. After its first usage, even after washing, there is a possibility that some of the chemicals remain on the PPE or within the material and can continue to permeate through the material between uses.

It is important to note, that permeation of chemicals can often occur without any visual change to the PPE leaving the material apparently unaltered. Thus, visual inspection alone does not necessarily indicate the PPEs are suitable for re-use.

> **"THIS MEANS THAT YOU MAY BE EXPOSED TO RESIDUAL CHEMICALS THAT ARE PRESENT INSIDE THE PPE WHEN USING FOR A SECOND TIME."**

PERMEATION

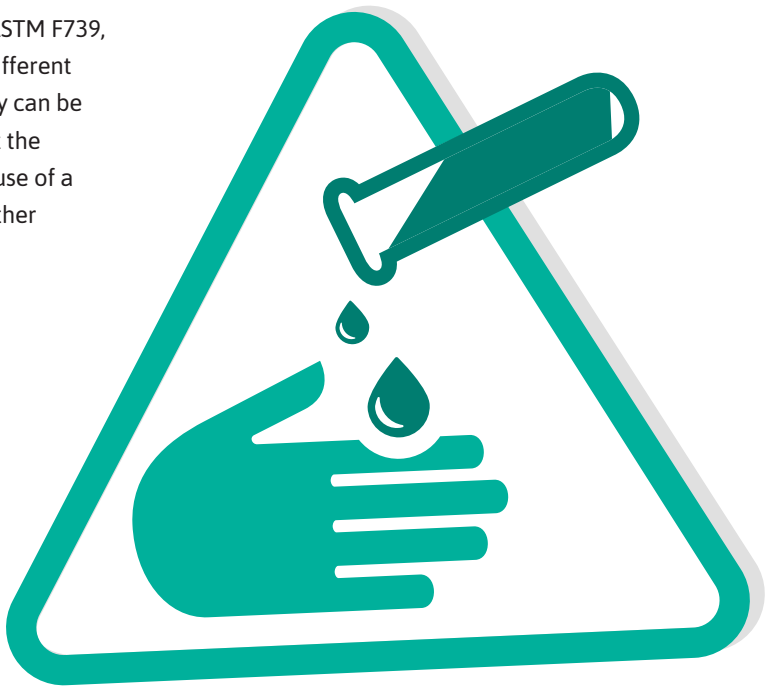
Permeation is where chemical adsorbs onto the surface of the material, diffuses through the polymer and desorbs from the other side in an unobservable molecular process.



HOW LONG I CAN WEAR AN ITEM OF PPE?

Standardised test methods, such as EN ISO 374, ISO 6529 and ASTM F739, have been put in place to assess **the relative performance** of different materials against degradation or permeation interactions. They can be used to **compare** the protective properties of materials against the hazardous substances handled in the application through the use of a 'breakthrough time'. This should be used in conjunction with other application specific data as part of an on-site risk assessment when assigning wear times.

> **"STANDARD TEST METHODS ASSESS HOW THE PERFORMANCE OF A PPE MATERIAL OR SEAM, WHICH HAS BEEN EXPOSED TO CHEMICALS, DIFFERS FROM AN UNEXPOSED SAMPLE."**



A breakthrough time is the time taken for a chemical to permeate the material at a set rate defined by the standard under laboratory conditions. Depending on which standard is being referred to, this limit is usually 0.1 ug per cm squared per minute or 1.0 ug per cm squared per minute.

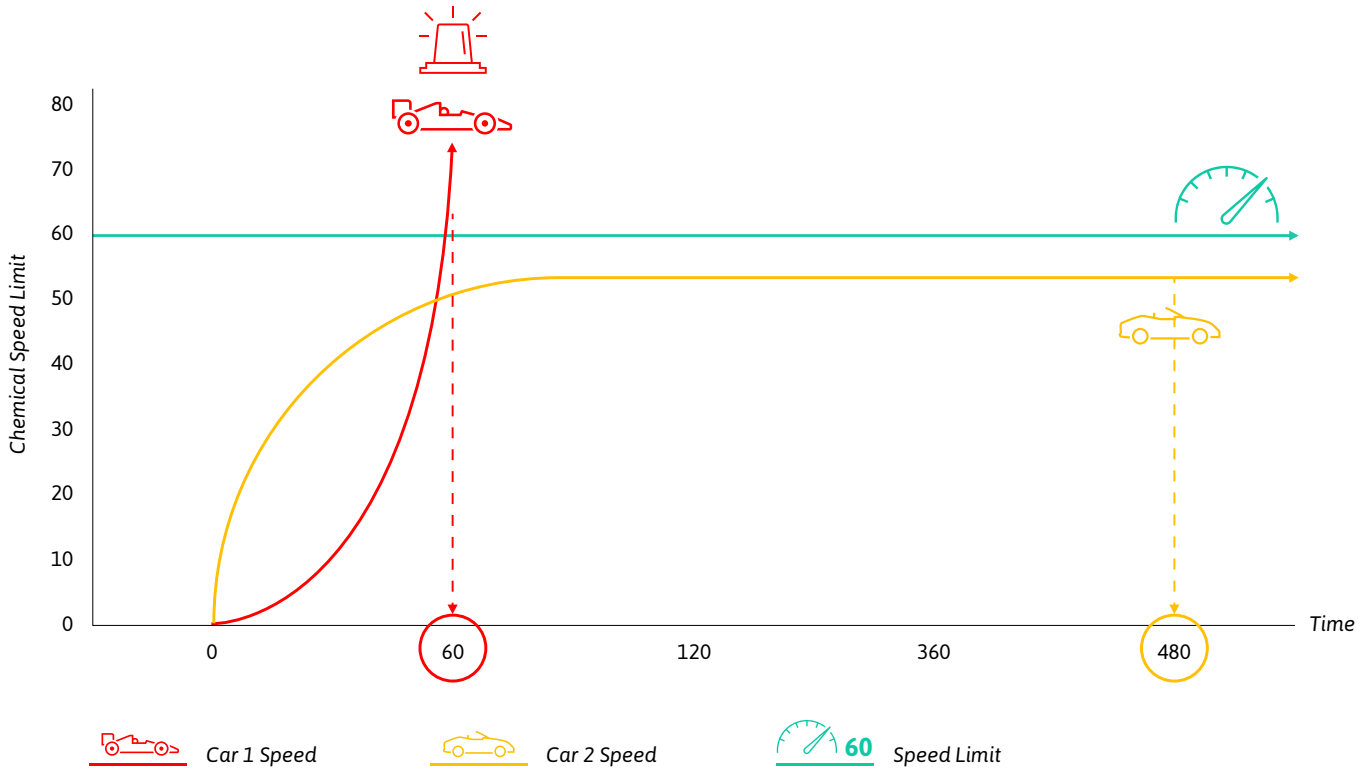
To understand what this means, imagine if you are driving a car on a road with a 60 miles per hour speed limit, you can travel at 55mph for 8 hours as you are underneath the speed limit. However, if you choose to break the speed limit at 1 hour and are captured by a speed camera or stopped by the authorities, you will have travelled a much shorter distance and be unable to continue your journey.

This same concept applies to permeation classification levels if we take the speed limit to be the breakthrough rate. The travel time corresponds to **breakthrough time**. The distance travelled however corresponds to the **cumulative permeation** – this is the total mass of chemical that has permeated each square centimetre of material during that time.

In this example, a Class 6 garment with a breakthrough time of >480 minutes has let through 440 µg cm-2 of challenge chemical. However, a Class 3 garment replaced at 60 minutes has only let through 40 µg cm-2.

This is extremely important to take into account when the chemical is toxic/harmful in very low quantities and an important value to include in risk assessments.

BREAKTHROUGH TIMES AND CUMULATIVE PERMEATION



When considering wear times and reusability, it is critical to consider the possible methods of chemical contamination. Cumualtive permeation is normalised to a small area. Surface area of contamination and risk of repeat exposure can substantially alter the efficacy of PPE, which is why it's always better to exercise caution and replace PPE immediately.

WHY IS CUMULATIVE PERMEATION IMPORTANT?

When it comes to assessing wear times of chemical PPE, it is extremely important to consider the toxicity of the chemicals that are being handled.

Chemicals can have **acute toxicity**, such as burns from chlorine or hydrogen cyanide, with immediate effect. However, often unseen and unnoticed for some time is **chronic toxicity**, such as skin sensitisers and carcinogens. Exposure to chemicals with chronic toxicity, even at low levels, can result in a bioaccumulation in the body over time and illness or disease when it reaches a critical amount.

The fruit and vegetables below all contain toxic chemicals however, they are in such low doses the body can regulate and expel them to negate the effects of unwanted build-up in the body.

Occupational exposure to toxins will be over much longer timescales than eating fruit and vegetables, and your effective dosage of a toxic chemical could be well over the advised exposure limits (even with >480 minutes breakthrough time).

It is important to consider the cumulative permeation during your application to know the amount of chemical you are handling and compare to toxicity to understand what this means for the end-user's health.

Just because a chemical has a breakthrough time of >480 minutes, does not mean it is not present in a harmful amount before that.

Apple (Seeds)

Amygdalin

Pears

Formaldehyde

Potatoes

Solanin

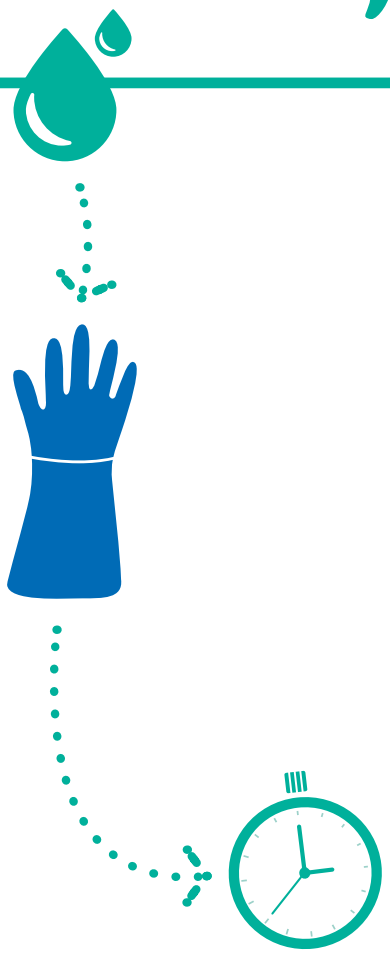
Courgettes

Cucurbitacin E

> **"JUST BECAUSE A CHEMICAL HAS A BT0.1 = > 480 MINUTES, DOES NOT MEAN THAT IT IS NOT PRESENT IN A HARMFUL AMOUNT BEFORE THAT TIME"**

HOW DOES THIS RELATE TO MY APPLICATION?

> **"WEAR TIMES EVEN FOR THE SAME MATERIAL AND CHEMICAL WILL BE UNIQUE AND SHOULD BE REVIEWED ON A CASE-BY-CASE BASIS AND CORRESPOND TO REAL ON-SITE CONDITIONS."**



This understanding of additional factors which can impact performance reinforces the message that breakthrough time does not correspond to a "safe use" time. Only when taking other factors for your individual application into account alongside these considerations can a wear time be determined.

Standardised testing is performed under laboratory conditions, so personalised in-application conditions which can affect the performance of the material, are not taken into account. There are various other factors which can impact the duration which a PPE can be worn for, such as:

- **Chemical toxicity**
- **Hand, chemical and environmental temperature**
- **Secondary mechanical risk**
- **Synergistic interactions between components when handling mixtures**
- **Synergistic interactions between repeat exposure of different contaminants**

The analytical methods suggested for standardised testing are only suitable for detecting single pure chemicals. If mixtures have been tested, they typically do not differentiate between components and include many assumptions.

When handling mixtures such as petrol, the toxic component of interest is benzene. Only permeation data that has selectively analysed for detection of the benzene component would be able to give a true indication of the material performance and PPE efficacy against this carcinogen. Most methods will only detect for all volatile organic chemicals, which include a number of other less toxic hydrocarbons, and is therefore not selective. Additionally, as traditional detection is calibrated based only on a single component, it is not possible to say how much chemical is permeating! So traditional permeation techniques are neither selective, nor quantitative. Single chemical data may also not be a true indication, as synergistic interactions between components could change the PPE performance.

Single chemical data is helpful for material comparison purposes, but in your end use, chemical mixtures may be handled more often. This can affect the amount of chemical permeation in a number of ways.

- **Synergistic interactions can reduce breakthrough times and increase cumulative permeation when compared to single chemicals.**
- **Unwanted chemical reactions can turn chemical contaminants into other hazardous permeating species.**

Both of these interactions could even be present with cleaning solutions, therefore it is also important to include this in PPE assessments.

WHAT TEMPERATURES AM I WORKING WITH?

Standardised testing is performed under laboratory conditions, typically at 23 degrees Celsius.

IS THERE A MECHANICAL RISK IN MY APPLICATION?

Tasks including both mechanical risk (such as abrasion or risk of tear and puncture) and chemical risk may have a reduction in performance and can impact the wear time.

HOW AM I POTENTIALLY BEING EXPOSED TO HAZARDOUS SUBSTANCES?

We have already found evidence that laboratory condition test methods do not necessarily correlate to the performance of PPE in application specific exposure methods (vapour, spray, immersion). The method of contact and volume of chemicals handled should also be considered in assessment of PPE wear time.

AnsellGUARDIAN®

AnsellGUARDIAN® Chemical was created to house all of the chemical permeation and degradation data for Ansell's chemical PPE range. The system currently contains data for over 41,000 chemicals with many of these being chemical mixtures. AnsellGUARDIAN® Chemical allows for comparison between materials to facilitate glove and suit selection.

> **"BY PROVIDING DATA FOR ANSELL'S CHEMICAL PROTECTIVE HAND AND BODY PROTECTION RANGE, AnsellGUARDIAN® CHEMICAL IS AN IDEAL TOOL TO AID IN THE SELECTION OF THE APPROPRIATE PPE."**

TAKEAWAYS

- Understand **importance** of reducing **chronic**, often **unseen** and un-noticed, chemical **exposure**
- See how Ansell is **pushing the boundaries** of the Science of Protection
- See how this can **support** you in **improving customer confidence** in Ansell's chemical expertise

Ansell invites chemical industry executives to learn more about the AnsellGUARDIAN® Chemical program and the full range of hand protection solutions available to protect their workers. For more information, visit **www.ansell.com/en/Campaigns/FeelEquipped.aspx**

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