

Understanding Permeation and Permeation Test Data

Permeation is the process by which a chemical will pass through a fabric at a molecular level. Many users of chemical suits refer to 'breakthrough' in a permeation test to indicate that a suit is safe to use. However, they are often unaware that permeation testing is intended for comparison of fabric performance only and is not suitable to indicate safe use. This article explains why.

If you are involved in chemical suit selection you will be familiar with chemical permeation test breakthrough times - often (incorrectly) used to indicate whether a wearer is safe or not against a specific chemical.

However, test breakthrough does not indicate when the chemical first breaks through the fabric, but is recorded when the RATE OF PERMEATION reaches $1.0\mu\text{g} / \text{min} / \text{cm}^2$. (Point B on the graph) (*In the CE standard test. The ASTM standard test uses $0.1\mu\text{g} / \text{min} / \text{cm}^2$)

Thus, as the graph indicates, at the point of test breakthrough the chemical has already been permeating through the fabric and may have come into contact with the user.

Does this mean you are safe or not?

Without more analysis of the volume permeated and the toxicity of the chemical, you simply don't know. The fact is, permeation test breakthrough provides no information about how long a user is safe against a specific chemical.

What should permeation test breakthrough be used for?

The CE Test standard EN 6529 clearly states that permeation test data is intended for comparison of fabric permeation resistance performance - in other words it can indicate whether the performance against a chemical is better for one fabric than another. The standard also states that permeation test data cannot be used to indicate whether a wearer is safe or not for any specific duration.



The problem of temperature

All permeation tests are conducted at 23°C in order to ensure compatibility of results. However, it is known that permeation rate increases with temperature. So if you work in a higher temperature than 23°C the permeation test may be indicating a much lower rate of permeation than in the real world where permeation may occur much more quickly.

So how do you know how long you are safe?

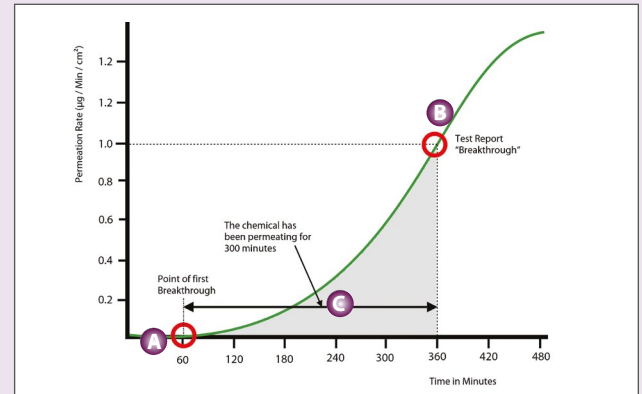
Safe-use time - the time a chemical suit can be worn before permeated volumes of the chemical may reach levels that may cause harm - can be calculated.

This requires information on permeation rate (taking into account the effect of temperature), the toxicity of the chemical and duration and extent of possible contamination.

However, PermaSURE® is a free downloadable tool that calculates safe use time for ChemMax® 3, ChemMax® 4 Plus and Interceptor® Plus coveralls against over 4,000 chemicals in seconds.



Graph of Permeation Rate



- Most users believe the 'breakthrough' quoted in chemical permeation test results is at **A** - where the chemical is first identified 'breaking through' the fabric.
- However, 'breakthrough', (more correctly called 'normalised breakthrough') is actually measured at the point when the RATE or SPEED that permeation is taking place reaches $1.0\mu\text{g}/\text{Min}/\text{cm}^2$ - at **B** on the graph.
- At the point of breakthrough **B** therefore the chemical has already been permeating through the fabric since the point of first breakthrough at **A** and may have come into contact with the wearer. (duration of permeation is indicated by **C** on the graph).
- Given that the shaded area below the line represents the volume (per min per cm^2) permeated through the fabric in that time, the question is 'Will that volume cause harm?'
- The answer depends on the toxicity of the chemical. For chemicals that present a long term hazards such as carcinogens, this might be critical.

Permeation test data and the problem of long term toxicity

Chemicals that present an immediate hazard - such as acids that burn or toxins that have an immediate effect are less problematic.

However, given that a chemical is permeating through the fabric before the test 'breakthrough' is reached, for users relying on test breakthrough as an indication of a safe use time, long term toxicity presents a real and possibly unrecognised risk.

If users wear a chemical suit on a regular basis to protect against such a chemical, under the impression (from permeation test data) that NO chemical is permeating through the fabric, it is quite possible that they are coming into contact with small quantities of the chemical on a regular basis and over a long period of time.

If this is the case, whilst no indication of any problem is apparent on a day to day basis... only in the long term as health problems develop will the hazard become apparent.

If you rely solely on permeation test breakthrough to indicate safe-use you might be coming into contact with longer term toxicity chemicals on a regular basis... without even knowing it.



PermaSURE® is Lakeland's free smartphone app that quickly calculates real world safe-wear times for chemical suits. Find out more here: <https://www.lakeland.com/europe/permasure>