DUPONT

Tychem® TK

Technical Handbook


Content

Tychem® TK

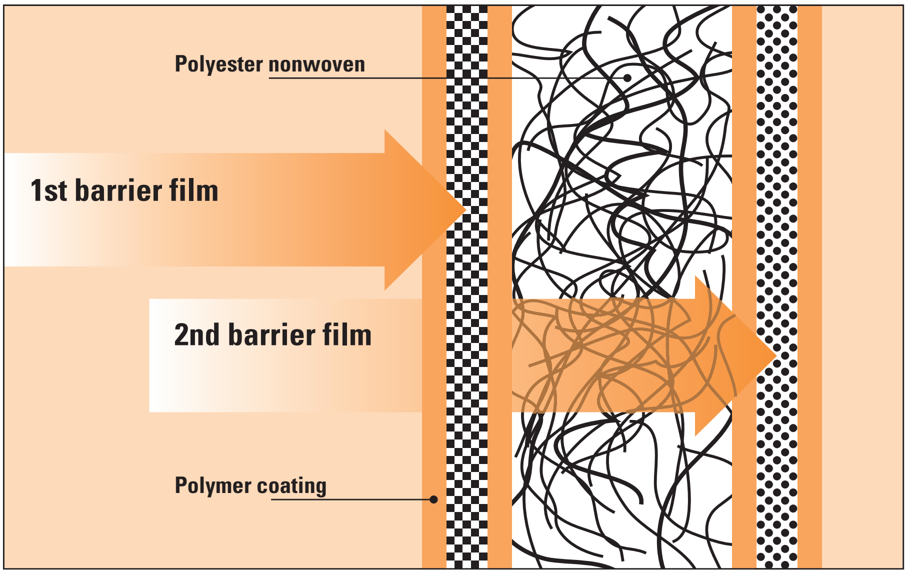
Intended use of Tychem® TK

Tychem® TK is a high performance chemical protective clothing material developed by DuPont for protection against gaseous, liquid or solid chemicals. It is mainly used in the manufacture of limited-use gas-tight (Type 1), non gas-tight (Type 2) and liquid-tight (Type 3) chemical protective suits.

Limited-use protective clothing is made to provide an optimised combination of adequate protection and comfort as needed for limited wear life usage. Limited-use clothing, i.e. clothing for limited wear life usage, is typically employed to be worn until hygienic cleaning becomes necessary or chemical contamination has occurred and disposal is required. This includes protective clothing for single use and for limited re-use according to manufacturer's instructions.

Tychem® TK passes the requirements of the European Norm prEN 943-1 & 2 – limited-use.

Tychem® TK – composition



Tychem® TK barrier material consists of high strength, high tear-resistant proprietary non-halogenated barrier films separated by 100% nonwoven polyester staple fabric.

Major benefits of Tychem® TK at a glance

- ➜ Outstanding chemical barrier properties
- ➜ Light weight, supple and flexible
- ➜ High material strength and tear resistance
- ➜ High visibility lime yellow colour
- ➜ Physical properties maintained over a wide temperature range
- ➜ Availability of barrier data for a wide range of chemicals
- ➜ Availability of technical data and technical support

Physical properties

Mechanical properties of Tychem® TK

Property	Test method	Property value of Tychem® TK	Performance class of Tychem® TK	Minimum performance class required by prEN 943-1	Minimum performance class required by prEN 943-2
Basis Weight	ISO 536	331 g/m^2	N/A	N/A	N/A
Thickness	ISO 534	730 µm	N/A	N/A	N/A
Abrasion resistance	EN 530 Method 2 & prEN 943-1	> 2000 cycles	6 (out of 6)	3	3
Stability to heat	ISO 5978	Slight blocking	N/A	N/A	N/A
Flex cracking resistance	ISO 7854 Method B & prEN 943-1	> 1000 cycles (MD) > 1000 cycles (XD)	1 (out of 6) 1 (out of 6)	1 1	1 1
Trapezoidal tear resistance	ISO 9073-4	164 N (MD) 215 N (XD)	6 (out of 6) 6 (out of 6)	3 3	3 3
Puncture resistance	EN 863	49 N	2 (out of 6)	2	2
Resistance to ignition	prEN 1146 & prEN 943-1	Does not continue to burn	Pass	Pass	N/A
	prEN 1146 & prEN 943-2	Does not continue to burn after 1 sec. flame exposure	1 (out of 2)	N/A	1
Surface Resistivity	EN 1149-1	10^{13} Ohm	N/A	N/A	N/A

N/A = Not applicable MD = Machine direction XD = Cross direction

■ The prelimanary European standards prEN 943-1 and prEN 943-2 – limited-use, EN 466, prEN 466-2 and prEN 1511 specify the test methods applicable for Type 1, Type 2 and Type 3 limited-use chemical protective clothing and define performance classes for different properties of protective clothing materials.

Temperature range: -70 °C to 90 °C. Tychem® TK exhibits less than 2 % shrinkage at 100 °C, no visible shrinkage at 70 °C and does not become brittle or fracture after 1 hour immersion in liquid nitrogen (-196°C). The material will begin to soften above 90 °C. The auto ignition temperature is in excess of 350 °C.

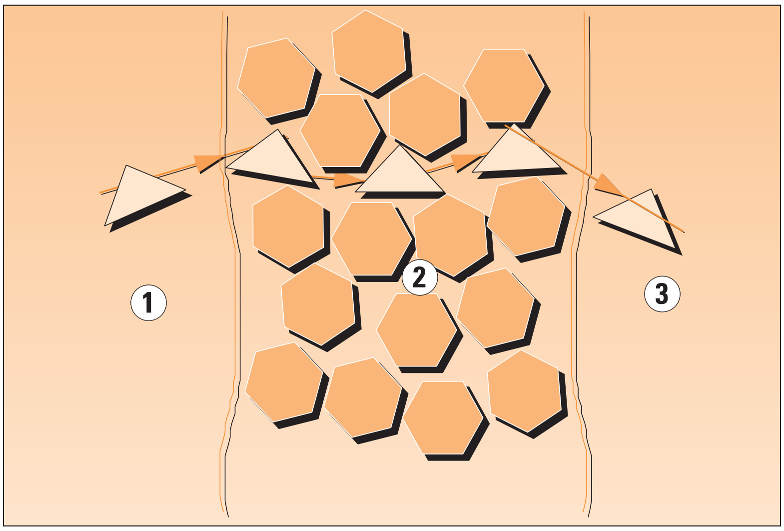
Note: This usable temperature range is based on the evaluation of the physical properties of the material only. Be aware that resistance to permeation by chemicals varies heavily with temperature.

Tychem® TK meets the resistance to ignition requirements but it is not flame resistant. Therefore suits made fromTychem® TK should not be worn in a potentially flammable or explosive environment since there is no anti-static treatment applied to Tychem® TK.

Chemical permeation

What is permeation?
Permeation is the process by which a chemical moves through a protective clothing material on a *molecular* level.

Fig. 1 **Permeation**

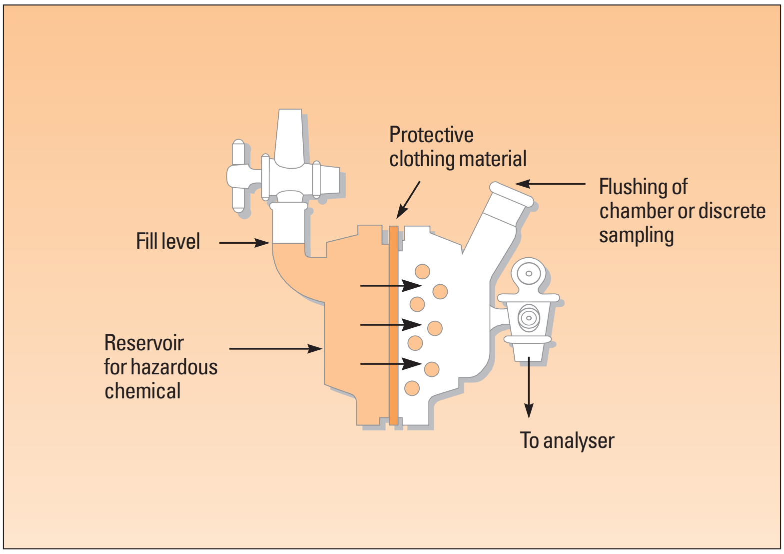


① Sorption of molecules of liquid liquid onto the contacted (outside) surface of the material ② Diffusion of the sorbed molecules across the material ③ Desorption of the molecules from the opposite (inside)

Measuring permeation
The resistance of protective clothing material to permeation by a potentially hazardous chemical is characterised by the permeation rate of the chemical through the material and the breakthrough time.

Permeation tests are usually conducted following the ASTM F739, EN 369 or EN 374-3 test methods simulating continous direct contact between the chemical and the protective clothing material.

Fig. 2 **Permeation test cell**



Schematic of a permeation test cell
The outside surface of a test material is exposed to a chemical using a permeation test cell. Permeation of the chemical to the inside material surface is monitored by sampling the collection side of the cell and analytically determining when the chemical has permeated across the material.

Permeation Rate
The rate at which the hazardous chemical permeates through the test material.

The permeation rate is expressed as a mass of chemical passing through an area per unit of time.

$$\text{Permeation Rate} = \frac{\text{Mass}}{\text{Area x Time}} = \frac{\mu g}{cm^2 \text{ x minute}}$$

Steady State Permeation Rate (SSPR)

The constant permeation rate that occurs after breakthrough when chemical contact is continuous and all forces affecting permeation have reached equilibrium.

Minimum Detectable Permeation Rate (MDPR)

The minimum permeation rate that can be detected during the permeation test.

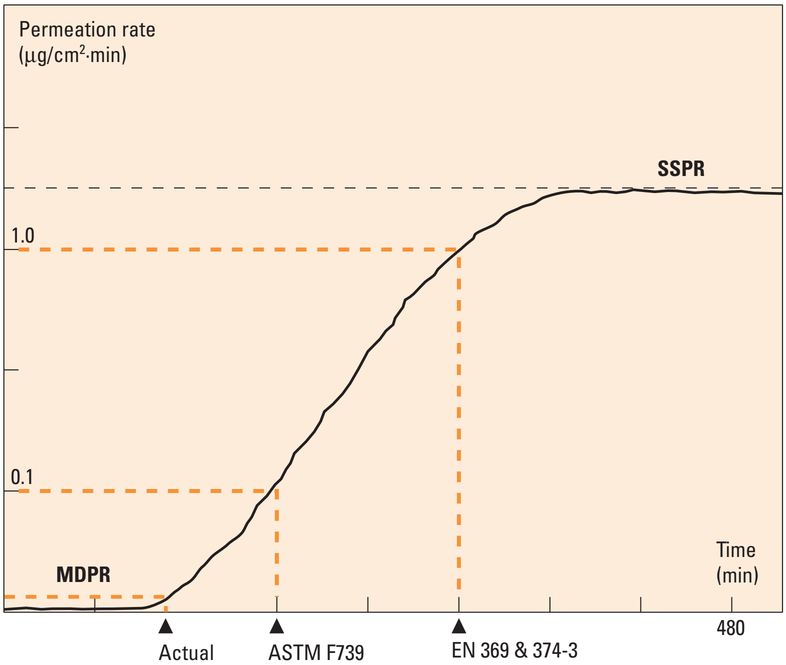
MDPR is a function of the sensitivity of the analytical measurement technique, the volume into which the permeated chemical is collected and the sampling time. Minimum detectable permeation rates can be as low as 0.001µg/cm²·min in certain cases.

Actual breakthrough time

The average elapsed time between initial contact of the chemical with the outside surface of the material and the time at which the chemical is detected at the inside surface of the material. Thus, the 'actual breakthrough time' is dependent on the analyser sensitivity.

An actual breakthrough time of > 480 minutes and a permeation rate of "nd" (not detected) does not mean breakthrough has not occurred. It means that permeation was not detected after an observation time of eight hours. Permeation may have occurred, but at a rate less than the minimum detectable permeation rate (MDPR) of analytical device. MDPR can vary depending on the chemical or on the analytical device.

Fig. 3 **"Typical" permeation cell results**



Breakthrough time

There exist three definitions of breakthrough time. When comparing 'breakthrough times' of various materials for a given chemical it is important to ensure that data based on 'like' definitions of breakthrough times are being compared.

Note: When selecting a chemical barrier material, the MDPR and expected exposure times are used to determine if the level of protection is sufficient taking into account the toxicity of the chemical used.

Normalised breakthrough time (according to ASTM F739)

The average elapsed time between initial contact of the chemical with the outside surface of the material and the time at which the chemical is detected at the inside surface of the material at a permeation rate of 0.1µg/cm²·min. Thus the breakthrough time is 'normalised' as it is independent of the analyser sensitivity.

Normalised breakthrough time (according to EN 369 & EN 374-3)

The average elapsed time between initial contact of the chemical with the outside surface of the material and the time at which the chemical is detected at the inside surface of the material at a permeation rate of 1µg/cm²·min. Thus the breakthrough time is 'normalised' as it is independent of the analyser.

Note: A normalised breakthrough time of > 480 minutes means that the average permeation rate never reached the defined rate of 0.1 µg/cm²·min (ASTM F739) or 1.0 µg/cm²·min (EN 369 & EN 374-3). However the chemical may have actually broken through.

Performance classification of normalised breakthrough times

Normalised breakthrough time (EN 369 & EN 374-3) minutes	EN class
≥ 10	1
≥ 30	2
≥ 60	3
≥ 120	4
≥ 240	5
≥ 480	6

How is permeation performance affected by temperature?

In general, permeation is expected to increase with increasing temperatures. However, there are a few exceptions to this generality. The temperature response of permeation rates depends on the barrier material and the chemical.

For example, at room temperature, a 6 °C increase in temperature will increase the permeation rate of simple gases through an oriented polyester film from 1.3 to 2.1 fold, depending on the gases[1]. This illustrates the behaviour of one film and a few chemicals within a narrow temperature range. There are many examples of anomalous behaviour, including chemical/barrier combinations for which permeation increases with decreasing temperature.

If temperature effects are critical to the end-user's applications, DuPont suggests that the end-user conduct specific tests at the relevant conditions to answer these questions for their particular situation and refers to country specific legal situations.

1 "Diffusion in Polymers", J. Crank and G. S. Park, Ed., Academic Press, 1968, PP 46-50

Interpreting test results

Breakthrough time does not necessarily imply "safe wear time".

A breakthrough time of x minutes does not mean that the material will offer safe protection for x minutes under the user specific wear conditions. Information on breakthrough times according to EN 369 and EN 374-3 or ASTM F739 allows a specifier to determine which materials are unsuitable barriers to specific chemicals.

Should a chemical permeate through a material, but fail to reach the defined permeation rate (EN 369 & EN 374-3) of 1 µg/cm^2 · min, the breakthrough time is reported as being > 480 minutes. A breakthrough time of > 480 minutes does not imply the chemical has not permeated through the fabric after 480 minutes. Breakthrough time alone does not allow a user to determine how long a person could wear a garment once contaminated. Taking an example of toxic chemical, a reported breakthrough time of eight hours can easily lead a specifier to believe the fabric will provide protection up to eight hours. This is clearly not the case, as the chemical can break through the fabric and toxic levels can be built up beneath a garment long before the reported breakthrough time of 480 minutes.

The "safe user wear time" of a protective garment depends on both the toxicity of the hazardous chemical and the quantity of chemical which permeates through the material, which is dependent on:

- permeation rate of the chemical through the material
- surface area contaminated
- temperature (permeation rates are usually adversely affected by higher temperatures)
- kind of exposure (continuous, intermittant, etc.)

Therefore, strictly speaking, breakthrough time alone is only a means of comparing different material performances. In order to estimate the safe protection wear time of chemical protective clothing, permeation rate, chemical toxicity and exposure conditions need to be taken into consideration.

Realising this is a complex evaluation the TYDAT Barrier Expert System has been developed. TYDAT is a chemical data-base containing the permeation curves and exposure limits for a wide range of chemicals to estimate the approximate safe user wear time for user-specific exposure conditions.

Chemical permeation data

How to use the permeation data
The permeation data on the following pages is organised alphabetically.

Independent testing
The permeation test results were conducted for DuPont mainly by the independent test laboratory TRI/Environmental Inc. The permeation results for Tychem® TK were determined using the test method ASTM F739, "Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids and Gases".

All permeation tests were conducted with pure chemicals at standard temperature and pressure unless otherwise specified. Sample results do vary and therefore averages for these results are reported.

Individual test certificates for each of the listed chemicals are available from DuPont on request.

Independent testing
DuPont can facilitate the independent permeation testing of your specific chemical or chemical mixtures with Tychem® TK.

Definition of terms

Physical state
The phase of the challenge chemical during the test being reported:

S = Solid
L = Liquid
G = Gas
M = Mixture

CAS no
Chemical Abstract Service Number. This number is unique for each chemical.

Permeation data

Chemical Name	CAS Number	Physical State	Average Breakthrough Time Actual (min.)	ASTM F739 normalised (min.)	EN 369 & EN 374-3 normalised (min.)	SSPR (µg/ cm² · min.)	MDPR (µg/ cm² · min.)
Acetaldehyde	75-07-0	L	> 480	> 480	> 480	< 0.01	0.01
Acetic Acid, Glacial	64-19-7	L	> 480	> 480	> 480	< 0.1	0.1
Acetic Anhydride	108-24-7	L	> 480	> 480	> 480	< 0.001	0.001
Acetone	67-64-1	L	> 480	> 480	> 480	< 0.01	0.01
Acetone Cyanohydrin	75-86-5	L	> 480	> 480	> 480	< 0.01	0.01
Acetonitrile	75-05-8	L	> 480	> 480	> 480	< 0.1	0.1
Acetyl Chloride	75-36-5	L	> 480	> 480	> 480	< 0.05	0.05
Acrolein	107-02-8	L	> 480	> 480	> 480	< 0.1	0.1
Acrylamide (50% in water)	79-06-1	M	> 480	> 480	> 480	< 0.1	0.1
Acrylic Acid	79-10-7	L	> 480	> 480	> 480	< 0.06	0.06
Acrylonitrile	107-13-1	L	> 480	> 480	> 480	< 0.003	0.003
Adiponitrile	111-69-3	L	> 480	> 480	> 480	< 0.1	0.1
Allyl Alcohol	107-18-6	L	> 480	> 480	> 480	< 0.1	0.1
Allyl Chloride	107-05-1	L	> 480	> 480	> 480	< 0.06	0.06
Ammonia	7664-41-7	G	> 480	> 480	> 480	< 0.1	0.1
Ammonia (-70° C)	7664-41-7	L	> 480	> 480	> 480	< 0.1	0.1
Ammonium Hydroxide, 28%	1336-21-6	L	> 480	> 480	> 480	< 0.1	0.1
Amyl Acetate n-	628-63-7	L	> 480	> 480	> 480	< 0.003	0.003
Aniline	62-53-3	L	> 480	> 480	> 480	< 0.1	0.1
Arsine	7784-42-1	G	> 480	> 480	> 480	< 0.01	0.01
Benzene	71-43-2	L	> 480	> 480	> 480	< 0.001	0.001
Benzene Sulfonyl Chloride	98-09-9	L	> 480	> 480	> 480	< 0.1	0.1
Benzidine (75% in Methanol)	92-87-5	M	> 480	> 480	> 480	< 0.1	0.1
Benzonitrile	100-47-0	L	> 480	> 480	> 480	< 0.004	0.004
Benzoyl Chloride	98-88-4	L	> 480	> 480	> 480	< 0.05	0.05
Benzyl Chloride	100-44-7	L	> 480	> 480	> 480	< 0.01	0.01
Black Liquor	–	M	> 480	> 480	> 480	< 0.01	0.01
Boron Trifluoride Etherate	353-42-4	L	> 480	> 480	> 480	< 0.1	0.1
Bromine	7726-95-6	L	15	15	–	25	< 0.01
Bromine (sat'd Vapor)	7726-95-6	G	40	40	> 480	> 0.6	0.1
Bromine (10g/m² Exposure)	7726-95-6	L	> 480	> 480	> 480	< 0.1	0.1
Bromofluorobenzene p-	460-00-4	L	> 480	> 480	> 480	< 0.001	0.001
Butadiene 1,3-	106-99-0	G	> 480	> 480	> 480	< 0.07	0.07
Butanol n-	71-36-3	L	> 480	> 480	> 480	< 0.002	0.002
Butyl Acetate n-	123-86-4	L	> 480	> 480	> 480	< 0.01	0.01
Butyl Acrylate n-	141-32-2	L	> 480	> 480	> 480	< 0.02	0.02
Butylamine n-	109-73-9	L	> 480	> 480	> 480	< 0.01	0.01
Butyl Ether n-	142-96-1	L	396	> 480	> 480	0.001	0.001
Butyraldehyde n-	123-72-8	L	> 480	> 480	> 480	< 0.007	0.007
Carbon Disulfide	75-15-0	L	> 480	> 480	> 480	< 0.02	0.02
Carbon Monoxide	630-08-0	G	330	330	> 480	0.1	0.1
Carbon Tetrachloride	56-23-5	L	> 480	> 480	> 480	< 0.015	0.015
Chlordane	57-74-9	L	> 480	> 480	> 480	< 0.01	0.01
Chlorine	7782-50-5	G	> 480	> 480	> 480	< 0.02	0.02
Chlorine (-70° C)	7782-50-5	L	> 480	> 480	> 480	< 0.01	0.01
Chlorine Trifluoride	7790-91-2	G	45	45	–	96	0.1
Chloroacetic Acid	79-11-8	L	> 480	> 480	> 480	< 0.1	0.1
Chloroaniline p-	106-47-8	S	> 480	> 480	> 480	< 0.09	0.09

Key:
imm = immediate; nm = not measured; nd = nothing detected
N/A = not applicable; > = greater than; < = smaller than
L = Liquid; G = Gas; S = Solid
M = Mixture; SSPR = Steady State Permeation Rate; MDPR = Minimum Detectable Permeation Rate

Chemical Name	CAS Number	Physical State	Average Breakthrough Time			SSPR	MDPR
			Actual (min.)	ASTM F739 normalised (min.)	EN 369 & EN 374-3 normalised (min.)	(µg/ cm^2 · min.)	(µg/ cm^2 · min.)
Chloroaniline p- (70°C)	106-47-8	L	323	344	–	9.4	0.001
Chlorobenzene	108-90-7	L	> 480	> 480	> 480	< 0.001	0.001 Chlo-
roethanol 2-	107-07-3	L	> 480	> 480	> 480	< 0.008	0.008
Chloroform	67-66-3	L	> 480	> 480	> 480	< 0.004	0.004
Chloromethyl Methyl Ether	107-30-2	L	305	> 480	> 480	0.03	0.001
Chlorophenol p- (Sat'd in Methanol)	106-48-9	L	> 480	> 480	> 480	< 0.013	0.013
Chlorosulfonic Acid	7790-44-5	L	> 480	> 480	> 480	< 0.1	0.1
Chlorotoluene o-	95-49-8	L	> 480	> 480	> 480	< 0.0001	0.0001
Cresol (Mixed Isomers)	108-39-4	L	> 480	> 480	> 480	< 0.01	0.01
Crude Oil	68308-34-9	L	> 480	> 480	> 480	< 0.04	0.04
Cumeme	98-82-8	L	> 480	> 480	> 480	< 0.01	0.01
Cyclohexane	110-82-7	L	> 480	> 480	> 480	< 0.003	0.003
Dichloroacetone 1,3- (40° C)	534-07-6	L	> 480	> 480	> 480	< 0.1	0.1
Dichloroaniline 3,4-	95-76-1	S	> 480	> 480	> 480	< 0.001	0.001
Dichloroaniline 3,4- (70°C)	95-76-1	L	216	284	–	2.4	0.001
Dichloroethane 1,2-	107-06-2	L	> 480	> 480	> 480	< 0.002	0.002
Dichloromethane	75-09-2	L	> 480	> 480	> 480	< 0.03	0.03
Dichloroethyl Ether	111-44-4	L	> 480	> 480	> 480	< 0.01	0.01
Dichloropropane 1,2-	78-87-5	L	> 480	> 480	> 480	< 0.01	0.01
Dichloropropene 2,3-	78-88-6	L	> 480	> 480	> 480	< 0.008	0.008
Diesel Fuel	68334-30-5	L	195	> 480	> 480	0.09	0.016
Diethylamine	109-89-7	L	> 480	> 480	> 480	< 0.1	< 0.1
Diethylenetriamine	111-40-0	L	> 480	> 480	> 480	< 0.01	0.01
Di (2-ethylhexyl) phthalate	117-81-7	L	> 480	> 480	> 480	< 0.07	0.07
Diethyl Sulfate	64-67-5	L	> 480	> 480	> 480	< 0.1	0.1
Dimethylamine	124-40-3	G	> 480	> 480	> 480	< 0.05	0.05
Dimethylacetamide N,N-	127-19-5	L	> 480	> 480	> 480	< 0.006	0.006
Dimethylaniline N,N-	121-69-7	L	> 480	> 480	> 480	< 0.013	0.013
Dimethyldichlorosilane	75-78-5	L	> 480	> 480	> 480	< 0.1	0.1
Dimethyl Ether	115-10-6	L	> 480	> 480	> 480	< 0.07	0.07
Dimethylformamide N,N-	68-12-2	L	> 480	> 480	> 480	< 0.01	0.01
Dimethylhydrazine 1,1-	57-14-7	L	> 480	nm	> 480	nd	5
Dimethyl Sulfate	77-78-1	L	> 480	> 480	> 480	< 0.001	0.001
Dimethyl Sulfoxide	67-68-5	L	374	> 480	> 480	0.003	0.003
Dinitro-o-Cresol	534-52-1	L	> 480	> 480	> 480	< 0.013	0.013
Dioxane 1,4-	123-91-1	L	> 480	> 480	> 480	< 0.05	0.05
Diphenyl Methane Diisocyanate 4,4'-	101-68-8	S	> 480	> 480	> 480	< 0.07	0.07
Epichlorohydrin	196-89-8	L	> 480	> 480	> 480	< 0.014	0.014
Ethanolamine	141-43-5	L	> 480	> 480	> 480	< 0.1	0.1
Ethyl Acetate	141-78-6	L	> 480	> 480	> 480	< 0.06	0.06
Ethyl Acrylate	140-88-5	L	> 480	> 480	> 480	< 0.02	0.02
Ethylbenzene	100-41-4	L	> 480	> 480	> 480	< 0.001	0.001
Ethyl Cellosolve®	110-80-5	L	> 480	> 480	> 480	< 0.008	0.008
Ethyl Chloride	75-00-3	G	> 480	> 480	> 480	< 0.02	0.02
Ethyl Cellosolve® Acetate	111-15-9	L	> 480	> 480	> 480	< 0.002	0.002
Ethylene Dibromide	106-93-4	L	> 480	> 480	> 480	< 0.1	0.1
Ethylene Dichloride	107-06-2	L	> 480	> 480	> 480	< 0.01	0.01
Ethyleneimine	151-56-4	L	> 480	> 480	> 480	< 0.01	0.01

Permeation data cont'd

Chemical Name	CAS Number	Physical State	Average Breakthrough Time: Actual (min.)	Average Breakthrough Time: ASTM F739 normalised (min.)	Average Breakthrough Time: EN 369 & EN 374-3 normalised (min.)	SSPR ($\mu g/cm^2 \cdot min.$)	MDPR ($\mu g/cm^2 \cdot min.$)
Ethylene Oxide	75-21-8	G	> 480	> 480	> 480	< 0.1	0.1
Ethylene Oxide (0º C)	75-21-8	L	> 480	> 480	> 480	< 0.01	0.01
Ethylene Oxide (10% in HCFC)	Mixture	L	> 480	> 480	> 480	< 0.02	0.02
Ethyl Parathion	56-38-2	L	> 480	> 480	> 480	< 0.01	0.01
Ethyl Ether	60-29-7	L	> 480	> 480	> 480	< 0.001	0.001
Fluorobenzene	462-06-6	L	> 480	> 480	> 480	< 0.1	0.1
Fluorosilicic Acid	16961-83-4	L	> 480	> 480	> 480	< 0.1	0.1
Fluorosulfonic Acid	7789-21-1	L	> 480	> 480	> 480	< 0.1	0.1
Formaldehyde, 37%	50-00-0	L	> 480	> 480	> 480	< 0.09	0.09
Formic Acid	64-18-6	L	> 480	> 480	> 480	< 0.01	0.01
Freon® 113	76-13-1	L	> 480	> 480	> 480	< 0.01	0.01
Furaldehyde 2-	98-01-1	L	> 480	> 480	> 480	< 0.01	0.01
Gasohol	Mixture	L	170	244	> 480	0.2	0.011
Gasoline, leaded	86290-81-5	L	> 480	nm	> 480	nd	nm
Gasoline, unleaded	8006-61-9	L	> 480	> 480	> 480	< 0.001	0.001
Glutaraldehyde (5% in Water)	111-30-8	M	> 480	> 480	> 480	< 0.1	0.1
Glutaraldehyde (50% in Water)	111-30-8	M	> 480	> 480	> 480	< 0.1	0.1
Green Liquor	N/A	M	> 480	> 480	> 480	< 0.01	0.01
Hexachlorobutadiene	87-68-3	L	> 480	> 480	> 480	< 0.01	0.01
Hexafluoroisobutylene	382-10-5	G	> 480	> 480	> 480	< 0.01	0.01
Hexamethylenediamine (45º C) 1,6-	124-09-4	L	> 480	> 480	> 480	< 0.01	0.01
Hexamethylenediisocyanate	822-06-0	L	> 480	> 480	> 480	< 0.01	0.01
Hexane n-	110-54-3	L	> 480	> 480	> 480	< 0.01	0.01
Hydrazine	302-01-2	L	> 480	> 480	> 480	< 0.05	0.05
Hydrazine Hydrate, 51%	10217-52-4	L	> 480	> 480	> 480	< 0.06	0.06
Hydrazine Hydrate, 85%	10217-52-4	L	360	440	> 480	0.06	0.004
Hydrochloric Acid, 37%	7647-01-0	L	> 480	> 480	> 480	< 0.02	0.02
Hydrofluoric Acid, 48%	7664-39-3	L	> 480	> 480	> 480	< 0.1	0.1
Hydrofluoric Acid, 70%	7664-39-3	L	> 480	> 480	> 480	< 0.1	0.1
Hydrofluoric Acid, 92% (90°C)	7664-39-3	L	67	nm	–	2.8	0.07
Hydrogen Bromide	10035-10-6	G	> 480	> 480	> 480	< 0.1	0.1
Hydrogen Chloride	7647-01-0	G	> 480	> 480	> 480	< 0.1	0.1
Hydrogen Cyanide	74-90-8	G	> 480	> 480	> 480	< 0.01	0.01
Hydrogen Cyanide	74-90-8	L	> 480	> 480	> 480	< 0.01	0.01
Hydrogen Fluoride	7664-39-3	G	> 480	> 480	> 480	< 0.1	0.1
Hydrogen Fluoride	7664-39-3	L	290	290	> 480	< 0.1	0.1
Hydrogen Peroxide, 30%	7722-84-1	L	> 480	> 480	> 480	< 0.04	0.04
Hydrogen Peroxide, 70%	7722-84-1	L	> 480	> 480	> 480	< 0.01	0.01
Hydrogen Sulfide	7783-06-4	G	> 480	> 480	> 480	< 0.01	0.01
Isopropylamine	75-31-0	L	> 480	> 480	> 480	< 0.01	0.01
JP-4 Jet Fuel	N/A	L	> 480	> 480	> 480	< 0.017	0.017
JP-8 Jet Fuel	94114-98-6	L	> 480	> 480	> 480	< 0.01	0.01
Lewisite	541-25-3	L	–	720	–	< 0.012 $\mu g/cm^2 \cdot min$ *	
Limonene d-	5989-27-5	L	> 480	> 480	> 480	< 0.001	0.001
Lannate® LV (29% Methomyl)	16752-77-5	L	> 480	> 480	> 480	< 0.1	0.1
Lindane (Sat'd in Acetone)	58-89-9	L	> 480	> 480	> 480	< 0.06	0.06
Lindane (Sat'd in Methanol)	58-89-9	L	> 480	> 480	> 480	< 0.01	0.01
Malathion	121-75-5	L	> 480	> 480	> 480	< 0.013	0.013

Key:
imm = immediate; nm = not measured; nd = nothing detected
N/A = not applicable; > = greater than; < = smaller than
L = Liquid; G = Gas; S = Solid
M = Mixture; SSPR = Steady State Permeation Rate; MDPR = Minimum Detectable Permeation Rate
* cumulative permeation

Chemical Name	CAS Number	Physical State	Average Breakthrough Time			SSPR	MDPR
			ASTM F739 normalised (min.)	Actual (min.)	EN 369 & EN 374-3 normalised (min.)	(µg/ cm^2 · min.)	(µg/ cm^2 · min.)
Malathion (50% in Methanol)	121-75-5	M	> 480	> 480	> 480	< 0.1	0.1
Mercuric Chloride, sat.	7487-94-7	L	> 480	nm	> 480	nd	0.28
Mercury	7439-97-6	L	> 480	> 480	> 480	< 0.0002	0.0002
Methacrylic Acid	79-41-4	L	> 480	> 480	> 480	< 0.01	0.01
Methanol	67-56-1	L	> 480	> 480	> 480	< 0.1	0.1
Methyl Acrylate	96-33-3	L	> 480	> 480	> 480	< 0.01	0.01
Methylamine	74-89-5	G	> 480	> 480	> 480	< 0.06	0.06
Methylamine (40% in Water)	74-89-5	L	203	254	–	1.9	0.001
Methyl Bromide	74-83-9	G	> 480	> 480	> 480	< 0.01	0.01
Methyl Cellosolve®	109-86-4	L	> 480	> 480	> 480	< 0.01	0.01
Methyl Cellosolve® Acetate	110-49-6	L	> 480	> 480	> 480	< 0.01	0.01
Methyl t-Butyl Ether	1634-04-4	L	> 480	> 480	> 480	< 0.007	0.007
Methyl Chloride	74-87-3	G	> 480	> 480	> 480	< 0.02	0.02
Methylene Bis (O-Chloroaniline)	101-14-4	L	> 480	> 480	> 480	< 0.1	0.1
(Sat'd in Methanol) 4,4'-							
Methylene Dianiline (15% in MEK) 4,4'-		101-77-9	L	> 480	> 480	> 480	< 0.1
0.1							
Methyl Ethyl Ketone	78-93-3	L	> 480	> 480	> 480	< 0.007	0.007
Methyl Ethyl Ketoxime	96-29-7	L	> 480	> 480	> 480	< 0.1	0.1
Methylglutaronitrile 2-	4553-62-2	L	> 480	> 480	> 480	< 0.1	0.1
Methyl Hydrazine	60-34-4	L	> 480	> 480	> 480	< 0.01	0.01
Methyl Iodide	74-88-4	L	> 480	> 480	> 480	< 0.01	0.01
Methyl Isobutyl Ketone	108-10-1	L	120	> 480	> 480	0.001	0.001
Methyl Isocyanate	624-83-9	L	> 480	> 480	> 480	< 0.01	0.01
Methyl Mercaptan	74-93-1	G	> 480	> 480	> 480	< 0.001	0.001
Methyl Methacrylate	80-62-2	L	> 480	> 480	> 480	< 0.02	0.02
Methyltrichlorosilane	75-79-6	L	> 480	> 480	> 480	< 0.1	0.1
Mineral Spirits	64475-85-0	L	> 480	> 480	> 480	< 0.01	0.01
Mustard	505-60-2	L	–	> 720	–	< 0.2 µg/cm^2·min *	
Nicotine	54-11-5	L	> 480	> 480	> 480	< 0.1	0.1
Nickel Carbonyl	13463-39-3	G	> 480	> 480	> 480	< 0.04	0.04
Nitric Acid, 70%	7697-37-2	L	> 480	> 480	> 480	< 0.1	0.1
Nitric Acid, 103%, Red Fuming	7697-37-2	L	390	390	> 480	3.6	0.1
Nitric Oxide	10102-43-9	G	> 480	> 480	> 480	< 0.04	0.04
Nitrobenzene	98-95-3	L	> 480	> 480	> 480	< 0.1	0.1
Nitrogen Tetroxide Gas	10544-72-6	G	90	90	> 480	> 1.1	0.003
Nitrogen Tetroxide (0°C)	10544-72-6	L	450	450	> 480	0.2	< 0.1
Nitromethane	75-52-5	L	> 480	> 480	> 480	< 0.005	0.005
Nitropropane 2-	79-46-9	L	> 480	> 480	> 480	< 0.01	0.01
Octane n-	111-65-9	L	> 480	> 480	> 480	< 0.01	0.01
Oleum, 40% free SO_3	8014-95-7	L	> 480	> 480	> 480	< 0.04	0.04
Oleum, 65% free SO_3	8014-95-7	L	> 480	> 480	> 480	< 0.1	0.1
Oxalic Acid (10.5% in Water)	144-62-7	L	> 480	> 480	> 480	< 0.1	0.1
Paraphenylene Diisocyanate (PPDI)	Mixture	L	> 480	> 480	> 480	< 0.1	0.1
crude mixture							
Parathion	56-38-2	L	> 480	> 480	> 480	< 0.01	0.01
PCB 50%/Trichlorobenzene 50%	Mixture	L	> 480	> 480	> 480	< 0.001	0.001
Pentachlorophenol (Sat'd in Methanol)	87-86-5	M	> 480	> 480	> 480	< 0.013	0.013
Pentenenitrile 2-	25899-50-7	L	> 480	> 480	> 480	< 0.001	0.0001

Permeation data cont'd

Chemical Name	CAS Number	Physical State	Average Breakthrough Time Actual (min.)	ASTM F739 normalised (min.)	EN 369 & EN 374-3 normalised (min.)	SSPR (µg/ cm^2 · min.)	MDPR (µg/ cm^2 · min.)
Pentenenitrile 3-	4635-87-4	L	> 480	> 480	> 480	< 0.001	0.001
Perchloric Acid, 70%	7601-90-3	L	> 480	> 480	> 480	< 0.1	0.1
Phenol, 90%	108-95-2	L	> 480	> 480	> 480	< 0.07	0.07
Phenol (45° C)	108-95-2	L	150	130	> 480	2.8	0.01
Phosgene Gas	75-44-5	G	> 480	> 480	> 480	< 0.1	0.1
Phosphine	7803-51-2	G	> 480	> 480	> 480	< 0.01	0.01
Phosphoric Acid, 85%	7664-38-2	L	> 480	> 480	> 480	< 0.1	0.1
Phosphorous Oxychloride	10025-87-3	L	> 480	> 480	> 480	< 0.1	0.1
Phosphorus Trichloride	7719-12-2	L	> 480	> 480	> 480	< 0.1	0.1
Picoline 2-	109-06-8	L	> 480	> 480	> 480	< 0.02	0.02
Picoline 3-	108-99-6	L	> 480	> 480	> 480	< 0.01	0.01
Potassium Acetate, sat.	127-08-2	L	> 480	nm	> 480	nd	0.49
Potassium Chromate, sat.	7789-00-6	L	> 480	nm	> 480	nd	0.51
Propylene Oxide 1,2-	75-56-9	L	> 480	> 480	> 480	< 0.002	0.002
Pyridine	110-86-1	L	> 480	> 480	> 480	< 0.01	0.01
Pyrrolidine	123-75-1	L	407	413	–	9.2	0.012
Sarin	107-44-8	L	–	> 1440	–	< 0.0002 µg/cm^2·min *	
Silane	7803-62-5	G	> 480	> 480	> 480	< 0.1	0.1
Silicon Tetrachloride	10026-04-7	L	> 480	> 480	> 480	< 0.1	0.1
Sodium Cyanide, 95%	143-33-9	L	> 480	nm	> 480	nd	0.3
Sodium Hydroxide, 50%	1310-73-2	L	> 480	> 480	> 480	< 0.1	0.1
Soman	96-64-0	L	–	> 720	–	< 0.0002 µg/cm^2·min *	
Stoddard Solvent	8052-41-3	L	> 480	> 480	> 480	< 0.001	0.001
Styrene	100-42-5	L	> 480	> 480	> 480	< 0.001	0.001
Sulfur Dichloride (80%)	10545-99-0	L	> 480	> 480	> 480	< 0.1	0.1
Sulfur Dichloride	10545-99-0	L	440	440	> 480	0.3	0.1
Sulfur Dioxide	7446-09-5	G	> 480	> 480	> 480	< 0.01	0.01
Sulfuric Acid, 93%	7664-93-9	L	> 480	> 480	> 480	< 0.1	0.1
Sulfuric Acid, 98%	7664-93-9	L	> 480	> 480	> 480	< 0.1	0.1
Sulfuric Acid, 103%, Fuming	8014-95-7	L	> 480	> 480	> 480	< 0.1	0.1
Sulfur Trioxide	7446-11-9	L	90	90	–	696	0.1
Sulfuryl Chloride	7791-25-5	L	> 480	> 480	> 480	< 0.1	0.1
Tabun	77-81-6	L	–	> 720	–	< 0.0002 µg/cm^2·min *	
Tetrachloroethane 1,1,2,2-	79-34-5	L	imm	> 480	> 480	0.005	0.00008
Tetrachloroethylene 1,1,2,2-	127-18-4	L	> 480	> 480	> 480	< 0.01	0.01
Tetraethyllead	78-00-2	L	> 480	> 480	> 480	< 0.07	0.07
Tetrahydrofuran	109-99-9	L	> 480	> 480	> 480	< 0.04	0.04
Thioglycolic Acid	68-11-1	L	> 480	> 480	> 480	< 0.1	0.1
Thionyl Chloride	7719-09-7	L	90	90	–	63.6	0.1
Titanium Tetrachloride	7550-45-0	L	> 480	> 480	> 480	< 0.1	0.1
Toluene	108-88-3	L	> 480	> 480	> 480	< 0.02	0.02
Toluene-1,3-Diisocyanate	26471-62-5	L	> 480	> 480	> 480	< 0.01	0.01
Toluene-2,4-Diisocyanate	584-84-9	L	> 480	> 480	> 480	< 0.01	0.01
Toluidine o-	95-53-4	L	> 480	> 480	> 480	< 0.001	0.001
Trichlorobenzene 1,2,4-	120-82-1	L	> 480	> 480	> 480	< 0.01	0.01
Trichloroethane 1,1,1-	71-55-6	L	> 480	> 480	> 480	< 0.004	0.004
Trichloroethane 1,1,2-	70-00-5	L	> 480	> 480	> 480	< 0.1	0.1
Trichloroethanol 2,2,2-	115-20-8	L	> 480	> 480	> 480	< 0.01	0.01

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Chemical Name	CAS Number	Physical State	Average Breakthrough Time Actual (min.)	ASTM F739 normalised (min.)	EN 369 & EN 374-3 normalised (min.)	SSPR (µg/ cm² · min.)	MDPR (µg/ cm² · min.)
Trichloroethylene	79-01-6	L	> 480	> 480	> 480	< 0.1	0.1
Trichlorophenylsilane	98-13-5	L	> 480	> 480	> 480	< 0.1	0.1
Triethylamine	121-44-8	L	> 480	> 480	> 480	< 0.01	0.01
Trifluoroethanol 2,2,2-	75-89-8	L	> 480	> 480	> 480	< 0.001	0.001
Trimethylamine	75-50-3	G	> 480	> 480	> 480	< 0.1	0.1
Vinyl Acetate	108-05-4	L	> 480	> 480	> 480	< 1	1
Vinyl Chloride	75-01-4	G	> 480	> 480	> 480	< 0.001	0.001
Vinylidene Chloride	75-35-4	L	> 480	> 480	> 480	< 0.01	0.01
VX	50782-69-9	L	–	> 720	–	< 0.0002 µg/cm²·min *	
White Liquor	N/A	M	> 480	> 480	> 480	< 0.01	0.01
Xylene (Mixed Isomers)	1330-20-7	L	> 480	> 480	> 480	< 0.004	0.004

Shelf life and storage

■ Based on the results of the accelerated ageing test, the projected shelf life of Tychem® TK is five years, as long as the material is not stored in sunlight or in excessive heat (> 40 °C). However, other materials used in chemical protective garments, such as gloves, closures, zippers, face shields, and flaps in exhaust valves, are often made from elastomeric materials which may have much shorter shelf storage times than the Tychem® TK material. For specific information on storage, shelf life, and routine maintenance of protective apparel ensembles please refer to the Tychem® TK use instructions.

Disposal

■ Tychem® TK is made of polymers which do not contain halogens in their structural formula. Depending on the chemical nature and the amount of contamination on the garments, garments made from Tychem® TK could be either incinerated after use, without any harm to the environment, or buried in a responsible way. On incineration of the garment itself, traces of halogens in combustion gases and ash are at the level of ordinary halogen contamination in any non-halogen containing industrial product.

Restrictions to the disposal of used Tychem® TK suits manufactured from Tychem® TK material depends on the contaminant.

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