

Chemical permeation testing of gloves

By Martin Heels



EN 374-3:2003 is to be replaced by EN 16523-1 for European PPE certification assessments.

With increasing consumer awareness of ethical trading and workplace health and safety requirements, it is important for businesses to protect employees from dangerous chemicals. To show that protective suits, gloves and footwear sold within the European Union have been type approved against the PPE Directive 89/686/EEC, they must bear the CE certification symbol. This is the case with all complex (category III) or intermediate (category II) PPE products.

In order to display the CE logo for chemically protective gloves, the Notified Body assessing the product will require testing to have been carried out in accordance with the EN 374 series of standards. The results of this testing will determine the relevant pictogram symbols that can be used on the packaging and labelling. The marking requirements will change, however, when the EN 374 series of test methods are revised.

Chemical hazards

When unprotected or insufficiently protected skin is exposed to chemicals, both short-term and long-term effects can

result. Local irritation of the skin (contact dermatitis) may be an obvious instant effect, although there may be other consequences of exposure. For example, the preservative formaldehyde and the disinfectant glutaraldehyde are both skin sensitisers. Once sensitisation has occurred, their presence can cause a reaction on the skin even in very small amounts. More corrosive chemicals, including sodium hydroxide, hydrofluoric acid and sulphuric

acid, will cause severe chemical burns.

While some organic solvents will not cause instant reactions, their long-term effects can be dangerous. Dichloromethane, for instance (which can be absorbed through the skin and is used in paint removers) is classified as a Category 3 carcinogen within the European Union. This is a substance of concern to humans due to possible health effects such as potentially causing lung and liver tumours. Any activity using these chemicals must ensure sufficient control measures are in place to minimise these hazards.

Protective gloves and breakthrough times

Both the material from which a protective glove is made and its thickness are important factors as to whether the glove will give sufficient protection against a particular chemical. A disposable natural latex glove will, for example, often give barrier protection against only dilute aqueous chemicals, whereas a thicker polychloroprene ('Neoprene') or polyvinyl chloride (PVC) gauntlet would be expected to give acceptable resistance against organic solvents such as methanol and acetone.

Natural latex is a material that is generally susceptible to permeation by organic solvents. Permeation is the process by which a chemical moves through the material at the molecular level. Sometimes this occurs without any physical changes to the material, such as swelling, cracking or a reduction in its elasticity.

To be certified as chemically protective

Table 1: List of test chemicals specified in EN 374-1:2003 Annex A			
Code letter	Chemical	CAS number	Class
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-8	Nitrile compound
D	Dichloromethane	75-09-2	Chlorinated paraffin
E	Carbon disulphide	75-15-0	Organic compound containing sulphur
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofuran	109-99-9	Heterocyclic and ether compound
I	Ethyl acetate	141-78-6	Ester
J	n-Heptane	142-85-5	Saturated hydrocarbon
K	40% Sodium hydroxide	1310-73-2	Inorganic base
L	96% Sulphuric acid	7664-93-9	Inorganic mineral acid

Table 2: Classification of performance levels

Measured breakthrough time (min)	Permeation performance level
>10	1
>30	2
>60	3
>120	4
>240	5
>480	6

and bear the conical flask pictogram (see page 10, figure 1), in addition to satisfying the requirements for EN 374-2 – ‘Resistance to penetration’, a glove must achieve at least performance level 2 for three or more chemicals from the 12 listed in the European standard EN 374-1:2003 Annex A (see table 1). The 12 chemicals were selected to represent some of the most common types of chemicals in industrial use. There are six different performance levels, depending on what is called the ‘breakthrough time’ (see table 2). This is the time from the start of the test to the time the chemical is detected moving through the material at a defined rate. The conical flask pictogram is printed on the certified gloves, and the letters below this pictogram denote the relevant code letter of the chemicals that achieved at least a performance level 2 when tested in accordance with EN 374-3:2003.

The conical flask pictogram can only be displayed if the glove also satisfies the EN 374-2 penetration requirements. A different beaker pictogram is used to indicate that the glove meets the penetration requirements and thus provides barrier protection (see page 10, figure 2). This beaker pictogram can also be used when the standard EN 374-3 is quoted on the packaging, when different chemicals to those listed in EN 374-1 Annex A have been tested to EN 374-3, or the conical flask pictogram criteria explained above are not achieved. Full details of the chemicals tested and performance levels achieved must be included in the user instructions. Both pictograms shall not be used together on the same glove.

EN 16523-1 and EN 374-1 changes

It has been more than 11 years since the current version of EN 374-3 was published. It is to be replaced by the new EN 16523-1



Many occupations require gloves to be worn to protect from potentially harmful chemicals

standard, which was developed specifically for the CE-marking of chemically protective gloves, clothing and footwear. This method is technically very similar to EN 374-3:2003, and there are no significant changes to the testing procedure. There will be changes, however, with the updated requirements standard (EN 374-1). It is proposed that the list of challenge chemicals will increase to 18, with the addition of the six chemicals listed in table 3. The labelling requirements will change significantly as a new classification approach has been adopted. Gloves will be classified as Type C if performance level 1 is achieved against at least one of the 18 listed chemicals. Type B classification is for gloves which meet level 2 against at least three of the 18 chemicals, and Type A gloves will achieve a performance level 2 against a minimum of six of the 18 chemicals.

Figure 1 shows the proposed new labelling for Type A gloves with the book symbol instructing the wearer to read the user instructions. The glove classifications must continue to satisfy the requirements of EN 374-2 – ‘Resistance to penetration’ and EN 420 – ‘General requirements’ as with the existing requirements. As a result of these three new classifications, the beaker pictogram will no longer be used. Currently, this beaker pictogram is also used to denote resistance to microorganisms if at least level

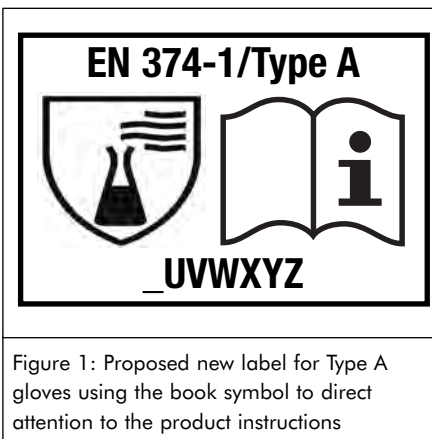


Figure 1: Proposed new label for Type A gloves using the book symbol to direct attention to the product instructions

2 is achieved for the acceptable quality limits (AQLs) in EN 374-2 Annex A. In the future, microorganism resistance will be detailed in a new standard – EN 374-5.

Testing at SATRA

SATRA's chemistry laboratory has an extensive range of detection techniques for use with permeation testing. Many more challenge chemicals than the 18 proposed in the EN 374-1 draft can be assessed against various types of materials and different constructions. Submitted technical files for EC type-examinations must contain satisfactory test reports against EN 374-3:2003 in order to be certified as being chemical resistant. From the data obtained in these reports, the product labelling and user instructions will inform the end-user if the gloves are suitable for an industry application.

Table 3: Additional chemicals proposed in prEN 374-1:2013			
Code letter	Chemical	CAS number	Class
M	65% Nitric acid	7697-37-2	Inorganic mineral acid
N	99% Acetic acid	64-19-7	Organic acid
O	25% Ammonia	1336-21-6	Organic base
P	30% Hydrogen peroxide	7722-84-1	Peroxide
Q	40% Hydrofluoric acid	7664-39-3	Inorganic mineral acid
R	37% Formaldehyde	50-00-0	Aldehyde

How can SATRA help?

For further information on the chemical permeation testing of gloves, please email chemistry@satra.co.uk