Protective suits standard in plant protection - DIN 32781

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Abstract

Handling of plant protection products may involve a risk potential for humans and the environment. Depending on the exposure situation, personal protective clothing may be prescribed as an operator protection measure. The protective suit is an important part of this protective clothing. A European network of standards regarding protective suits against chemicals exists. The conditions and test methods formulated in those standards cannot or only in exceptional cases be transferred to plant protection. Therefore, with DIN 32781 a standard with a special test method and corresponding specifications was introduced in Germany which is adjusted to plant protection requirements regarding protection, comfort and acceptance.

Keywords: Protective suits, plant protection, DIN 32781, atomiser test, penetration test, protection effect, wearing comfort, acceptance

Zusammenfassung

Die Norm zum Schutzanzug im Pflanzenschutz - DIN 32781

Der Umgang mit Pflanzenschutzmittel kann ein Gefährdungspotential für Mensch und Umwelt beinhalten. Als eine Maßnahme zum Schutz des Anwenders kann persönliche Schutzausrüstung vorgeschrieben werden, wenn es die Expositionssituation verlangt. Ein wichtiger Bestandteil dieser Schutzausrüstung ist der Schutzanzug. Es existiert ein Europäisches Netzwerk von Normen zu Schutzanzügen im Chemikalienschutz. Die dort formulierten Bedingungen und Prüfmethoden sind nicht oder nur begrenzt auf den Pflanzenschutz übertragbar. Deshalb wurde in Deutschland mit der DIN 32781 eine Norm eingeführt, die mit einer speziellen Prüfmethode und entsprechendem Anforderungsprofil hinsichtlich Schutz, Komfort und Akzeptanz an die Erfordernisse im Pflanzenschutz angepasst ist.

Schlüsselworte: Schutzanzug, Pflanzenschutz, DIN 32781, Schutzwirkung, Tragekomfort, Akzeptanz

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1 Introduction

Handling plant protection products may involve a risk potential for humans and the environment. For reasons of preventive health protection the use of personal protective clothing, e.g. wearing a protective suit, is required for professional application and for subsequent work on treated surfaces under certain conditions. This may become necessary if a plant protection product is labelled regarding its toxic properties. As chemicals, plant protection products are also subject to the regulations pertaining to hazardous substances (Gefahrstoffverordnung 2004; Gesetz zum Schutz von gefährlichen Stoffen; Directive of the European Parliament and Council 1967 and 1999).

In June 2006, 657 plant protection products (PPP) were authorised in Germany. To get an overview of relevant health classifications of these plant protection products refer to Figure 1.

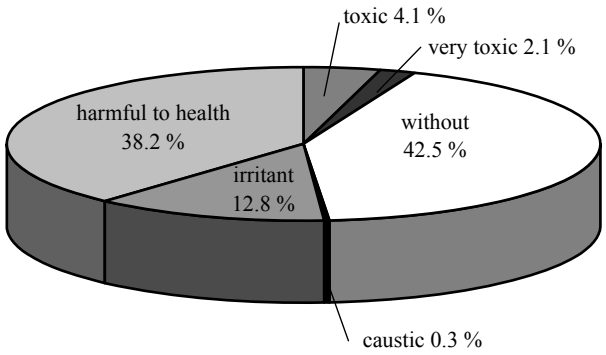

Figure 1:

Classifications of authorised plant protection products relevant to health (BVL (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit), update June 2006)

Based on the classification of plant protection products, respective hazard symbols and terms are assigned. Plant protection products with identified risks are additionally labelled with indications defining the risk (risk phrases, R 1 - R 68). Table 1 gives an overview of warning statements which are assigned due to adverse effects after skin contact and the frequency of assignment.

Safety phrases (S-phrases, 51 - 64) can be derived from the risk phrases and provide information on necessary protection measures when using the product. For example, S 36, which states that suitable protective clothing must be worn, is obligatory for very toxic and caustic substances and preparations, and also for substances and preparations which are assigned R 21 or R 24.

In addition to classification and labelling which is obligatory by law, the Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL) can prescribe labelling requirements for the protection of the operator within the context of authorisation in accordance with the German Plant Protection Act. These requirements stipulate, for example, wearing specific and suitable protective equipment under certain application conditions to reduce the risk of exposure.

Table 1:

Overview of warning statements, referring to the main exposure route „skin“ and the number of authorised plant protection products bearing such labelling. (BVL (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit), update June 2006)

Risk phrases	Hazard designation	Number of authorised PPP
R 21	Harmful in contact with skin	17
R 24	Toxic in contact with skin	1
R 27	Very toxic in contact with skin	0
R 34	Causes burns	2
R 35	Causes serious burns	0
R 38	Irritating to skin	81
R 43	May cause sensitisation by skin contact	154
R 66	Repeated exposure may cause skin dryness or cracking	16

These restrictions result on the one hand from the properties of the plant protection product and the classification according to the legislation on hazardous substances and on the other hand from the identification of the hazard potential for the operator. This identification can be carried through on the basis of measured data from field studies. Often, however, suitable mathematical models are used for this purpose (Lundehn et al., 1992; Joint Medical Panel, 1986; POEM UK 1992). By means of these models and under defined conditions of use, the exposure of the operator to the plant protection product is assessed. This value is compared to a suitable toxicological maximum value. If required, adequate protection measures, like the use of a protective suit, are prescribed by a use restriction.

According to European Union regulations, all components of safety at work must be certified and thus tested. The test methods should be the essence of European standards (EN) if available. Otherwise, it is possible to refer to national regulations, like in plant protection.

On the joint initiative of research, authorities and industry, the Federal Biological Research Centre for Agriculture and Forestry (BBA) published BBA Regulation, part I 3-3/2 (BBA, 1988) where, for example, protective suit requirements and the suitability test were described. This regulation was reviewed in 1997 (Hoernicke, 1997).

Due to legal and technical changes the regulation is currently being updated (BVL, 2006).

In the absence of a practical test to determine the plant

protection product permeability of textiles, a special method has been developed and introduced.

In order to do better justice to the significance of the protective suit when handling plant protection products, it was decided to define the suit by a standard and to establish criteria. Bringing about a national solution by a DIN became necessary as it has not been possible up to now to agree on this matter at European level (CEN). Nevertheless, it is at the European inspection authorities‘ and certifiers‘ liberty to follow these DIN standards.

2 Actual situation

The European standard determines six types of protective suits for chemicals in a network (Table 2). The starting point for the choice of a suitable type of protective suit is the nature of exposure which depends on the state and the properties of the chemical and on the way a chemical may come into contact with the protective suit.

Table 2:
Standardised chemical protective suits – classified in different types

Type1	Gas-tight suits (EN 943-1 and EN 943-2)
Type 1a	Gas-tight suits with breathing protection
Type 1b	Gas-tight suits with breathing protection
Type 1c	Gas-tight suits with internal excess pressure (ventilated suits)
Type 2	Non-gas-tight ventilated suits (EN 943-1)
Type 3	Protection from jets of liquid (EN 14605)
Type 4	Protection from spray (EN 14605)
Type 5	Protection from dust and solid particles (EN ISO 13982-1)
Type 6	Protection from minor splashes (limited protection effect) (EN ISO 13034)

Whereas the performance requirements regarding protection are prescribed by standards (EN), the Technical Report CEN TR 15419 gives detailed information on the choice, use and maintenance by means of the so-called SUCaM-procedure (Hinz, 2005). The general aim of this protection from chemicals is the protection from unforeseen events when handling chemicals (event of accidents) and not the protection required during long working hours with a relatively low exposure level, as is mostly the case in plant protection.

The requirements for a protective suit which is to protect the operator when handling plant protection products are established by DIN 32781. Emphasis is placed on the testing of textile material, and the seams and joins of the entire suit for plant protection product impermeability. The DIN is introduced in the following.

3 DIN 32781 protective clothing – protective suit for plant protection products

The standard DIN 32781 applies to protective suits which are used for the application of plant protection products and/or subsequent work in the field for arable and field crops and also to suits required for applications in greenhouses. Transferability is however only possible if the conditions of use in the greenhouse are comparable to those in arable and field crops. If this is not the case, the protective suit must meet the requirements of EN 14605 Type 4 *“Protective clothing for liquid chemicals – performance requirements for chemical protective suits with liquid-tight (Type 3) or spray-tight (Type 4) joins between the pieces of clothing, including those pieces which only provide cover for parts of the body”*.

According to the general structure of a DIN standard, the paragraphs 1 to 3 of DIN 32781 contain formulations on the field of application, normative references and terms and definitions. Paragraph 4 establishes requirements regarding mechanical properties, comfort and impermeability to chemicals. Table 2 of the DIN standard lists the assessment criteria, the corresponding measurement categories and their acceptable limit values and the test methods to be used.

The most important value as regards protection effect is the degree of penetration. The acceptable limit value is 5 %. The values for the mechanical strength of disposable suits have been kept deliberately low with 10 N for tear resistance, so that a damaged suit is recognised as such and will thus not be used again. For a reusable suit 20 N were established. In order to ensure reasonable wearing comfort, the water vapour volume resistance should not exceed 20 m^2 Pa/W.

The values listed in Table 3 apply to the material out of which the plant protection protective suit should be made. The seams and joins of a suit are often weak spots. These must be designed in a way which excludes the permeation of liquids. The test must be carried out together with the modified spray test according to EN 13034.

Seam strength is tested according to EN ISO 13935-2. The maximum tensile load must be at least 225 N for reusable suits and for disposable suits at least 30 N.

Paragraph 5 contains general performance requirements according to EN 340 for the entire suit and labelling information.

Table 3:
Plant protection protective suit requirements according to DIN 32781

Criterion	Measurement category	Limit value (protective suits)	Test method
Penetration	Degree of penetration	5 %	EN 14786
Strength	Maximum tensile load Tear resistance	500 N (30 N)* 20 N (10 N)*	EN ISO 13934-1 EN ISO 9073-4
Ergonomics	Water vapour volume resistance	$20 \frac{m^2 * Pa}{W}$	EN 31092
Acceptance	Make, design and price	-	-

* The values in brackets apply to the disposable suit

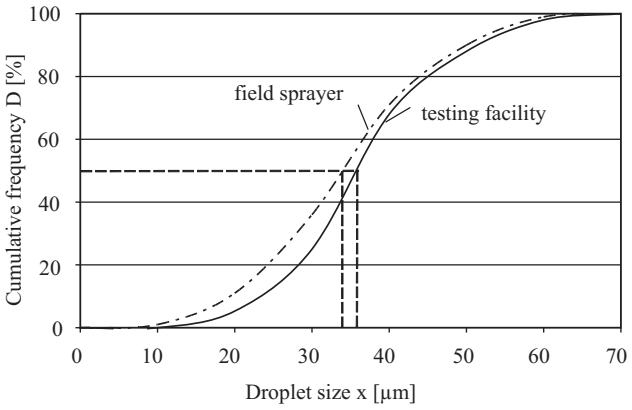

Figure 3:
Distribution of droplet size on the field and in the testing facility

4 Test methods for determining the degree of penetratio

For determining the degree of penetration for textile materials, the so-called *Gutter Test* is stated in the European act on toxic substances in compliance with EN ISO 6530 in which test fluid is applied to a piece of material and left to run down it, Figure 2 a. The results are assessed gravimetrically. The amount of liquid which penetrates the material (m_p) and the amount which runs down it (m_b) are determined. These values are calculated relative to the amount of liquid applied; the degree of penetration and repellence are thus calculated. Leachates and acids are used as test fluids.

Neither the kind of application nor the duration of contact are anywhere near the application conditions when plant protection products are applied.

For this reason, the spray method (*Atomiser Test*, Figure 2 b) in accordance with EN 14786 has been developed, which reproduces the amount applied and the kind of application when the liquid is sprayed. The size of the droplets as they land on the suit from the spray liquid is an extremely significant parameter. Figure 3 shows the distribution of droplet size during application in the field and in the test. The cumulative frequency is depicted in relation to the diameter of the drops. Parameters for characterising particle dispersion are the breadth of distribution and the average diameter as 50 % of the value of the cumulative distribution. The conditions in the field are depicted realistically by the testing facility.

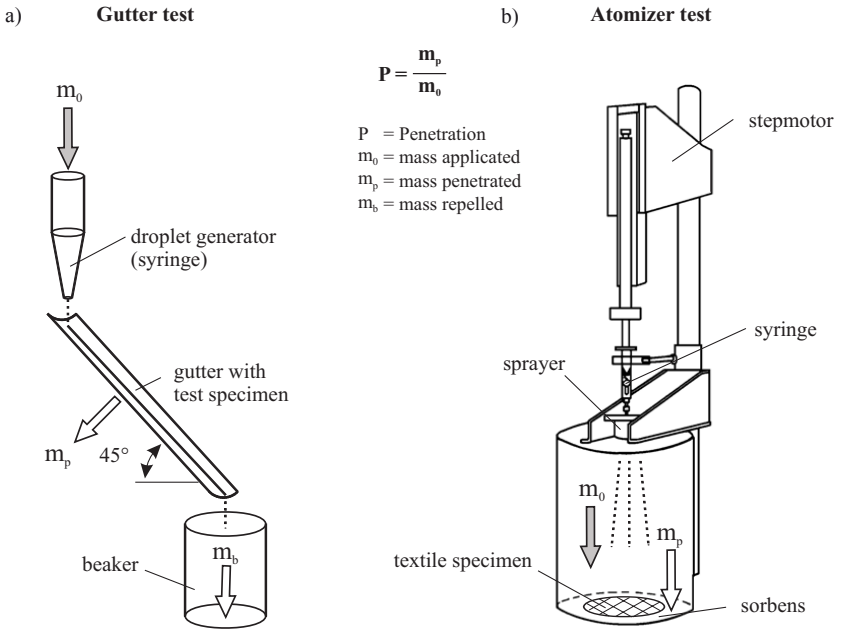

Figure 2:
Test methods for determining the degree of penetration(a: *Gutter Test* and b: *Atomiser Test*)

In the test, the degree of penetration is determined by the ratio of the amounts of applied plant protection product to the amounts permeating the swatch. For this purpose, the plant protection product is sprayed onto the swatch – with an underlying sorbent - using a two-component jet. After a contamination period of 20 minutes, swatch and sorbent are extracted and the corresponding amounts are determined by quantitative chemical analysis procedures. The degree of penetration is calculated according to the formula specified under Figure 2.

Because it is not practical to test one suit material with all authorised plant protection products, experts have selected five products which are considered representative due to their formulation and their use in the market (Table 4).

Table 4:
Plant protection products to be used for permeability testing

Trade name ZA-No.	Formulation	Active substance	Concentration of active substance in the product	Concentration of active substance to be tested in spray liquid	Concentration of product to be tested in spray liquid
U46-D-Fluid 0941-00	SL	2.4-D-DMA-Salt	500 g/l	2500 mg/l	5 ml/l
Pirimor Granulat 2470-00	WG	Pirimicarb	500 g/kg	750 mg/l	1.5 g/l
Amistar 5090-00	SC	Azoxystrobin	250 g/l	1250 mg/l	5 ml/l
Betanal Expert 4991-00	EC	Phenmedipham	75 g/l	563 mg/l	7.5 ml/l
Folicur 4028-00	EW	Tebuconazole	250 g/l	1250 mg/l	5 ml/l

Table 5 illustrates the results from testing three suit materials and two plant protection products. The materials R and G are fabrics for reusable suits, material N (non-woven) is designed for disposable suits.

Table 5:
Results of a test according to EN 14786

Textile	$P_{Phenmedipham}$ [%]	$P_{2.4\text{-}D}$ [%]
R	3.5 – 4,6	1.8 – 5
N	28 – 35	< 1
G	1.2 – 3.3	< 1

Section 4.2.1 of DIN 32781 prescribes the testing of seams and joins for the penetration of liquids. The test method is the modified spray test with detailed rules for the implementation according to EN 13034 section 5.2. In this test, a test person wearing the suit to be tested is sprayed with a defined amount of dyed liquid in a chamber while he goes through a seven-part sequence of movements on a treadmill. The penetrated liquid leaves coloured stains on the underwear. The stained area must not exceed three times the size of a calibration stain. EN 468 gives a detailed description of the spray test.

With this test it is easy to evaluate the quality of a clothing manufacturer's finish. Figure 4 shows an example of a badly finished seam. This suit would not be certified.

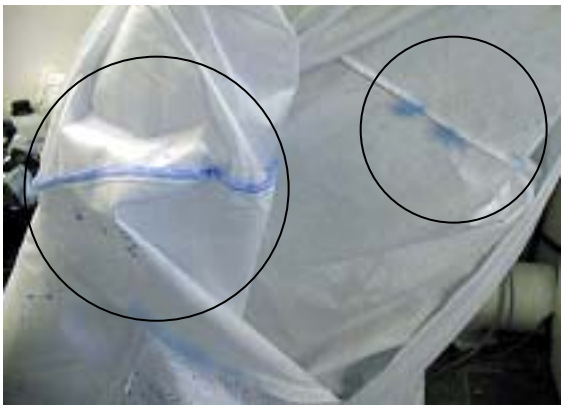

Figure 4:
Poor finish detected by spray test , photo: Sächsisches Textilforschungsinstitut e.V. – Chemnitz (Saxon Textile Research Institute, registered association, in Chemnitz)

In contrast to chemical protective suits which are standardised according to EN, merely the impermeability of seams and joins is tested on plant protection suits, and not the material itself which passed the atomiser test beforehand.

5. Concluding remark

If the authorisation of a plant protection product prescribes wearing a protective suit, this suit must meet the requirements of DIN 32781.

DIN 32781 established performance requirements for suits which take account of wearers' needs regarding protection effect, wearing comfort and acceptance. Apart from one special test method for the impermeability of the suit material, it is possible to refer to international CEN and ISO standards.

A solution for protective suit requirements for plant protection products, adapted to plant protection working conditions, has thus been found.

Acknowledgement

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Abbreviations

2.4-D-DMA-Salt = Dimethylamine-salt of 2.4-Dichlorphenoxy-acetic acid; CEN = Comité Européen de Normalisation (European Committee for Standardization; Europäisches Komitee für Normung); DIN = Deutsches Institut für Normung (German standard); ISO = International Organisation for Standardization; SUCaM = Selection, Use, Care and Maintenance

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