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# Recommendation for the Quality Assessment of the Product Performance of All-Purpose Cleaners\*

Keywords: All-purpose cleaner, cleaning performance, clear drying, material care

## Introduction

**A** recommendation developed by the companies Dalli-Werke GmbH & Co. KG, fit GmbH, Henkel KGaA, Institut Fresenius AG, Luhs GmbH, THURN-Produkte Adolf Thurn, Werner & Mertz GmbH within a working group of Industrieverband Körperpflege und Waschmittel e. V. (IKW – The German Cosmetic, Toiletry, Perfumery and Detergent Association); published by IKW in 2004.

Foreword to these recommendations:

1. Remit
2. Environment
3. Assessment of test results
4. Legal provisions and voluntary agreements (packing & labelling)
5. Further development

This commitment to sustainability as a guiding principle is built up on experiences expressed in numerous exemplary initiatives. Taking as starting points the Declaration of Rio 1992, »92+10« of Johannesburg and the Agenda 21, sustainability is understood as a balanced linking of economic, social and ecological aspects under the following definition: »Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs«.

With this in mind »Recommendations for quality assessment« serve to encourage company staff to act responsibly vis-à-vis humans and the environment in product development and manufacture. They also help fulfil consumer expectations in terms of efficacy, safety and environmentally sound products.

### 3. Assessment of test results

Quality standards determine which qualities are relevant to a given product and to what extent these qualities must be present. It should be noted that every finished product has a certain spectrum of quality characteristics largely determined by consumer expectations so that in each product some characteristics are deliberately emphasized while others seem less important. Moreover the desired combination of product properties is subject to constant change, depending on the latest technical possibilities and new consumer habits. Quality recommendations must not impair such developments. Consequently for each product only one overall result is valid to determine whether the product comes up to

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## ■ Foreword

### 1. Remit

IKW member companies make their expert knowledge of the products they manufacture available to the general public. This is done in the form of quality recommendations. The IKW retained the expert committee 'Cleaning and Maintenance Products' (Fachausschuss Putz- und Pflegemittel – FP) to elaborate on the recommendations presented here. The FP is composed of experts from competitor companies. This ensures the neutrality of the committee. Quality recommendations enable a qualified testing of

products by the companies themselves and by consumers and test institutes. Quality standards are laid down that need to be fulfilled by the products concerned in order to meet expectations of consumers and manufacturers.

### 2. Environment

Companies working within the framework of the IKW want optimal quality standards for their products. Their aim is a consistent orientation to sustainability as a guiding principle, preparing their companies to successfully face the future in a constantly changing world.

quality requirements or not. Emphasis on isolated test criteria is not admissible and may be misleading.

#### 4. Legal provisions and voluntary agreements

Where applicable the following statutory requirements in the valid versions must be observed with regard to composition, packaging and labelling:

- German foodstuffs and commodities act (Lebensmittel- und Bedarfsgegenständengesetz – LMBG)
- German chemicals act (Chemikaliengesetz – ChemG)
- German dangerous substances ordinance (Gefahrstoffverordnung – GefStoffV)
- Detergents Regulation (EC) No. 648/2004 (entry into force: 8 October 2005)
- German detergents and cleaning products act (Wasch- und Reinigungsmittelgesetz – WRMG), until 7 October 2005
- German surfactants ordinance (Tensidverordnung – TensV), until 7 October 2005
- German ordinance on pre-packaged products (Fertigverpackungsverordnung – FPV)
- German ordinance on the transport of dangerous goods by road (Gefahrgutverordnung Straße – GGVS)
- German ordinance on the transport goods by rail (Gefahrgutverordnung Eisenbahn – GGVE)
- Commission Recommendation 89/542/EEC of September 13, 1989 for the labelling of detergents and cleaning products, until 7 October 2005

Voluntary agreements:

- Use of child-resistant packing
- Ban of chlorinated organic solvents
- Ban of musk xylene from December 31, 1993

- Ban of alkyl phenol ethoxylates (APEO) from January 14, 1986
- Rules of procedure for notifications pursuant to paragraph 9 of the German detergents and cleaning products act (§9 WRMG) of December 5, 1988, until 7 October 2005

#### 5. Further development

The expert committee 'Cleaning and Maintenance Products' is aware that the further development of products as such and changes in inputs and consumer habits may necessitate a further development of these recommendations. Therefore the recommendations given here are subject to revisions and amendments in the light of changing market situations.

#### ■ 1. Introduction

All-purpose cleaners are, as well as hand dishwashing products and sanitary cleaners (bathroom and toilet), the most frequently used cleaning products in households (1). They are usually applied in diluted form to clean floors and surfaces (large surface applications) or they are used as concentrated products to remove persistent soiling and dirt stains (selective applications).

All-purpose cleaners are preparations consisting of various surfactant mixtures, water soluble solvents and complexing agents. They also contain additives such as perfumes and colourants as well as preservatives. Formulations are available as standard products or concentrates. There are neutral to alkaline formulations as well as acidic cleaners.

All-purpose cleaners with a wide range of perfumes are available on the market as special sales or seasonal products so that they cater for different preferences where fragrance is concerned.

Consequently for the quality assessment of such a widely marketed and much observed product a straightforward, reproducible and practice-orientated test method is desirable, both in external comparative testing and in product development.

The test method used to date is a quality standard for floor care and cleaning products of the Industrieverband Putz- und Pflegemittel (IPP – German association of manufacturers of cleaning agents) (2). As the PVC film required for this test is no longer available, a modified test method needed to be developed.

In order to develop such a method a working group composed of experts from companies manufacturing cleaning agents was constituted within, the IKW. Leading test institutes in this field, also participated in the relevant activities.

#### ■ 2. Aim

The aim of the working group was to develop the IKW recommendations for the quality assessment of the product performance of all-purpose cleaners. These recommendations are to enable a qualified testing by the manufacturers themselves and by independent test institutes.

The recommendations need to meet the following criteria:

- Practice relevance
- Reproducibility
- Differentiation between products
- Straightforward implementation, to the highest degree possible

#### ■ 3. Strategy followed by the working group

##### 3a) Product performance: cleaning performance

In testing according to the above-mentioned IPP method (2) used so far, a carrier treated with the test soil is scrubbed with a sponge soaked with the test product under defined conditions. The surface to be cleaned is white PVC, and the cleaning result is determined in comparison with a white standard using a reflectance colorimeter.

The test soil consisting of oil, petrol and black pigment as dyestuff was, to a higher or lesser degree, removed or smeared. First tests started with the definition of

a test soil relevant to practice. This was to be done for product use in concentrate and diluted forms as stated by the manufacturer.

For this purpose both the existing IPP method (2) and a published method (3) were chosen. The following variations were examined with different application techniques and different burn-on temperatures and durations:

*PVC plastic:* IPP method with two types of soil (use in concentrate and diluted forms).

*Ceramic floor tile:* Soil according to (3), an imitated dust/fat soil from the kitchen sector.

*Stainless steel:* Gravy sauce/condensed milk; slight deformation of test specimens when heating, consequently insufficient reproducibility of results.

*Melamine resin (kitchen worktop):* Fat-dust soil according to (3); deformation of test specimens when heating, consequently no ageing of soil possible.

*Enamel:* Proposed, but not pursued further because no suitable test specimens were obtainable.

*Acrylonitrile butadiene styrene (ABS) plastic:* Proposal, but not further pursued due to lack of heat stability.

A standard cleaner and dilutions of this cleaner were defined for ring tests and for a comparison of results (Annex I). Those different concentrations of the standard cleaner served to reflect different price segments in the market and different product qualities. Furthermore it was necessary to use a standard product independent of manufacturer as no changes to the formulation could be made at all or only after agreement. Then the standard cleaner and the dilutions were tested, using various scrub testers with a sponge, on the above-mentioned materials/types of soil to determine the cleaning performance of concentrate and dilutions. It emerged that no differentiation was possible in diluted application, although numerous tests were conducted to adapt the test design (burn-on temperature/duration/material etc).

The sponge as scrubber material was replaced by a cloth, because the latter is more relevant to practice and easier to handle. Also, results were easier to re-

produce. The sponge involved disadvantages with viscous products (delayed absorption), production salts had to be washed out, deformations occurred, and there were considerable differences in weight. A multi-track scrub tester was found to be the most suitable scrubbing device, because – as opposed to single-track scrub tester – it enables a comparison of several products and one standard on one and the same surface. The new test is based on standardisation against a standard cleaner.

The test method using a fat-dust soil according to (3) on a tile surface was revised in detail, described more precisely, and implementation was tried out in several ring tests.

### 3b) Product performance:

#### Clear drying and streak formation

So far clear drying behaviour was determined by (repeated) submerging in a diluted solution of product that contained a fatty soil (4). Usually no differences were observed that would have allowed conclusions as to different product performances. In the new method, scrubbing takes place with the diluted product on mirror tiles, and the scrubbing track is evaluated after drying in a comparison with water of defined hardness.

### 3c. Product performance:

#### material care

To evaluate material care, effects of the concentrated product on different material surfaces were examined. However material surfaces are frequently protected by a sealing/varnish so that materials are attacked only if such protective layers are damaged. Therefore a stress cracking corrosion test is performed with small plastic sticks made of different materials, based on German standard DIN 53449 T 1-3 (5).

## ■ 4. Test principle

Product performance is determined by way of the following measuring results:

- Cleaning performance
- Clear drying / Streak formation
- Material care

For further characterisation, without assessment, the pH value and sensorial properties (fragrance, colour) are determined.

## ■ 5. Description of method

### 5a) Cleaning performance in concentrated use

The test method to determine the cleaning performance of the concentrated product is based on a fat-dust soil dried and bonded over an extended period of time (3) which occurs mainly in kitchens. This is a very persistent type of soil.

#### Preparation and implementation

The test device is a multi-track scrub tester with cloth holder (supply source a), preferably a Sheen 903 PG (supply source b, for supply sources see item 7). The fat-dust soil (3) consists of:

75% peanut oil (e.g. Mazola)

23% Kaolin 60609 (e.g. Fluka)

2% Special Black 4 (Degussa), supply source g)

The maximum batch size should not exceed 1 kg.

Preparation: Taking the peanut oil as a basis and using a propeller stirrer, kaolin and special black are stirred in one after the other, followed by stirring for 30 minutes. This type of soil must age for one month at room temperature in a closed vessel without influence of light, as it is too easy to remove if used immediately. For test purposes 20% of the above soiling is diluted, under stirring, with 80% isopropanol.

The following use periods are recommended:

Oil: use at most 3 months after opening within minimum shelf-life.

Soil stock solution: After 1 month of ageing, use is possible within 2 months (storage at room temperature); if used over longer periods the soil becomes too persistent.

The isopropanol dilution can be used for 7 days with closed storage of the sprayable soiling solution. However the



Fig. 1 Application of test soil, using a stencil



Fig. 3 Application of test cleaner



Fig. 4 Test apparatus during the scrubbing process



Fig. 2 Weighing of tile with test soil

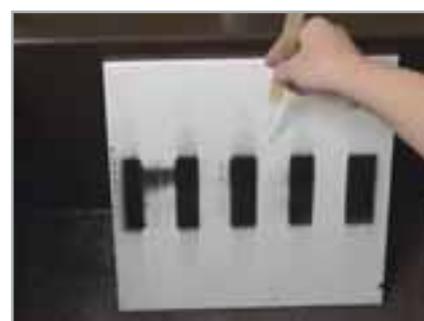


Fig. 5 Rinsing of tiles after the scrubbing process

maximum number of strokes should not exceed 40.

**Stirring times:** The freshly prepared stock solution of soil is stirred for 30 minutes with the propeller stirrer, as described above.

Renewed homogenisation of the stock solution of soil by stirring for one hour with the magnetic stirrer. Stirring time to produce the isopropanol dilution is 24 hours, renewed homogenization of the isopropanol dilution prior to each use by 30 minutes of stirring with the magnetic stirrer.

The diluted soil is sprayed with an air-brush, or by way of similarly suitable application methods, in an even layer onto a pure white, glazed floor tile (supply source h) on a surface of 8 x 26 cm (208 cm<sup>2</sup>), using a stencil. Prior to soiling, tiles must be wiped with alcohol and then rubbed dry; adhering wax must be removed.

Important: each tile may be used only once (Fig. 1).

The quantity of soil to be applied is 0.35 +/- 0.02 per tile; it is determined by dif-

ference weighing on the tile. Scales used for this purpose must have a precision of +/- 0.01 g (Fig. 2).

The soil is burnt on at 100°C over 24 hours in the circulating-air drying cabinet where the plates are placed individually next to each other on the grates. In multi-layer drying cabinets, it is essential to leave sufficient space between the plates to enable an even air circulation. The temperature profile must be measured, and the charging process must always be performed evenly. After cooling down to room temperature the plates are stored for 24 hours at room temperature for conditioning; then they can be used for up to 14 days if stored in an upright position in the laboratory.

The preparation of these test plates is the crucial part of this method and requires special care, particularly in respect of temperature control and temperature constancy inside the hot cabinet. The comparative assessment of the cleaning performance is made, using an automatic multi-track scrub tester, by scrubbing with a cloth onto which the test substance is pipetted (Fig. 3).

The cloths, preferably article no. 02010100 by the company Fa. Wecovi (supply source c), are selected by mean cloth weight +/- 1 g (e.g. 17-19 g / 20-22 g / 23-25 g uncut); cloths that display strong inhomogeneities against the light are sorted out. Homogeneous cloths of one weight range are cut, without any further preparations, to ca. 13 x 10 cm and used.

After inserting the cloth and attaching it, 5 ml of product are evenly pipetted on. When using multi-track scrub testers, fourfold measuring is made with randomised placing (see example test set-

up, Annex IV). Measuring takes place without additional bearing weights, as the own weight of the holder is 2687 g so that the bearing weight is 671.75 g per cloth holder (Fig. 4).

A suitable number of strokes is determined in a pre-test in order to have a clear differentiation; the scrubbing speed is 20 strokes/minute (1 stroke = one to-and-fro movement). The reference cleaner is adjusted as standard with at least 4 strokes (ideally 5-15 strokes) to cleaning value 2 (Annex II). After-treatment of tiles takes place immediately after cleaning with running cold water (moderate spray jet) with constant water hardness (Fig. 5). The subsequent drying period lasts approx. one hour. Plates dry standing upright at room temperature.

The assessment is made visually by way of inspection, in a comparison with an assessment scale (Annex II).

#### Assessment of cleaning performance

The plates are inspected by at least 3, but preferably 5, experienced persons in an independent assessment, with no knowledge of the respective product sample.

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*Determination of sequence and significance check*

Based on the assessment according to a scale of grades and expected results, non-parametric hypothesis tests (6,7) are selected for the purpose of statistical evaluation.

Depending on the chosen test design and the data situation (comparison in pairs of two products, multiple comparison of several products), several statistical tests are available for the evaluation of results (Table 1).

In the so-called hypothesis test (significance tests) the test method is intended to substantiate – based on test results – hypotheses (presumed facts) against incidental effects. The result of a statistical conclusion is a certain probability with which there is really a difference between two or several products. However probability also means that a statement made is never certain but always involves a certain error (a and b error).

The first step in a hypothesis test is to define two hypotheses – the null hypothesis (H0) and the alternative hypothesis (H1). Generally, the null hypothesis defines the presumption that there is no significant difference between two or several products to be compared. By contrast, the alternative hypothesis defines that there is a significant difference between two or several products to be compared.

Put into simpler words, the further course of action is the determination of a probability of error (usually determined for such tests is  $\alpha = 0.05$ ), the conversion of grades for assessment purposes into ranks, the calculation of a test statistic from the obtained rank sums, the determination of a critical value (threshold value) from the selected statistical distribution and – by comparing the test statistic with the critical distribution value – the decision on acceptance or rejection of the null hypothesis. For further details, readers are referred to relevant literature.

Multiple comparisons must be performed in two steps. In the first step (Kruskal-Wallis test) it is examined whether one or several of the tested cleaners are significantly different from each other (homogeneity test). Which products are significantly different from each other or iden-

Test design	suitable statistical tests
Comparison in pairs	Non-parametric, two-random sample test for independent random samples – U-test according to Mann-Whitney-Wilcoxon
Multiple comparison	Non-parametric, multi-random sample test for independent random samples – H-test according to Kruskal-Wallis and Non-parametric, multiple comparisons for independent random samples according to Nemenyi or Median test

**Table 1** Statistical test methods for the assessment of results of comparisons (in pairs or multiple)

tical can be found out in a second test (Nemenyi or Median test, respectively). Depending on whether the value of the test statistic is higher or lower than the tabulated distribution value, a decision

**5b) Clear drying behaviour / Streak formation**

All-purpose cleaners are used most frequently in diluted form. Therefore it is important to achieve, drying without

Rank:	1	2	3	4	5	6	7
Product no:	<u>7</u>	<u>5</u>	3	<u>4</u>	<u>6</u>	1	2

can be made on significant differences of results between two or more products. The outcome of a multiple comparison of several cleaners can be described e.g. in the following way, expressing product equalities by underlining (rank 1 = best product; rank 7 = worst product):

*Notes on the implementation:*

The scrubbing should consist between 10 and 40 strokes. If the minimum number of strokes is not reached, first the burn-on time should be extended by some hours. Should this not bring the desired result, the quality of the peanut oil used should be checked (added stabilisers inhibit or accelerate cross-linking, depending on age and condition of the oil). Higher temperatures as well as longer burn-on times and storage durations increase the number of strokes necessary.

*Description of the result for cleaning performance*

The result may be described only in connection with relevant test conditions, because the achieved cleaning performance depends on the number of times scrubbed.

residues to the largest extent possible.

*Preparation and implementation*

The test device is a multi-track scrub tester with cloth holder (supply source a), preferably a Sheen 903 PG (supply source b).

Products are tested on mirror tiles (supply source i): In preparation of the test they are wiped with alcohol and then rubbed dry.

Cleaners to be tested are, according to manufacturer's instructions, diluted with water 16.8 od German hardness (manufacturing instruction, Annex III) and homogenised. Cleaner dilutions may be used at most for one working day. Prior to further use they must be again homogenised.

The comparative assessment of clear drying behaviour and streak formation is carried out using an automatic multi-track scrub tester, by scrubbing with a cloth onto which the test substance is pipetted.

The cloths, preferably article no. 02010100 by the company Wecovi (supply source c), are selected by mean cloth weight +/- 1 g (e.g. 17-19 g / 20-22 g / 23-25 g uncut). Cloths that display strong inhom-

genieties against the light are sorted out. Then the cloths are washed once with liquid detergent and twice without (programme hot wash/coloured laundry 60 oC, initial water hardness constant, ideally 14-18 od) (also see description of results of clear drying/streak formation). The liquid detergent used should be clear without builders (without phosphates/zeolites etc) and no gel. Dosage for »normally soiled loads« according to manufacturer's instructions. Subsequently the cloths are dried for at least 18 hours at room temperature, hanging down vertically without clothes pegs. After complete drying the cloths are cut - e.g. with the help of a stencil - to 13 x 10 cm, once more selected by mean cloth weight +/- 0.1 g and used.

After inserting and attaching the cloth, 5 ml of product are evenly pipetted onto the cloth. When using multi-track scrub testers, measuring is made with randomised placing (see table/test design, Annex IV), with water 16.8 od simultaneously running to enable a comparison (example for six products and water in Annex IVa). Measuring takes place without additional bearing weights, as the own weight of the holder is 2687 g so that the bearing weight is 671.75 g per cloth holder.

5 strokes are performed, the scrubbing speed is 20 strokes/minute (1 stroke = one to-and-fro movement). There is no after-treatment of tiles but the visual inspection takes place after complete drying (approx. one hour, plates are dried lain down horizontally at room temperature). After the visual inspection the residues on the plates are assessed applying a scale of grades ranging from 0 - 4, 0 = no residues, 4 = very strong residues. Experience shows that in a direct comparison drop residues are assessed more negatively than streaks (Fig. 6). The inspection is made against a homogeneous dark or black background along the scrubbing streak, with the starting point upward (Fig. 7).

For better visibility it might be necessary to tilt the plate sideways. Assessment in a light box with halogen spot lights or a standard light box with D 65 light source has proven its worth.

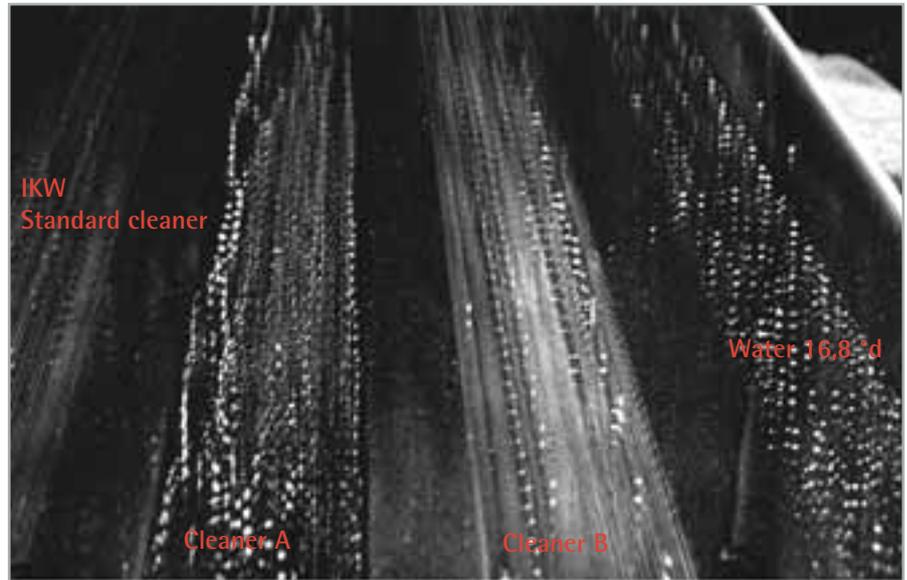


Fig. 6 Mirror with traces of wiping

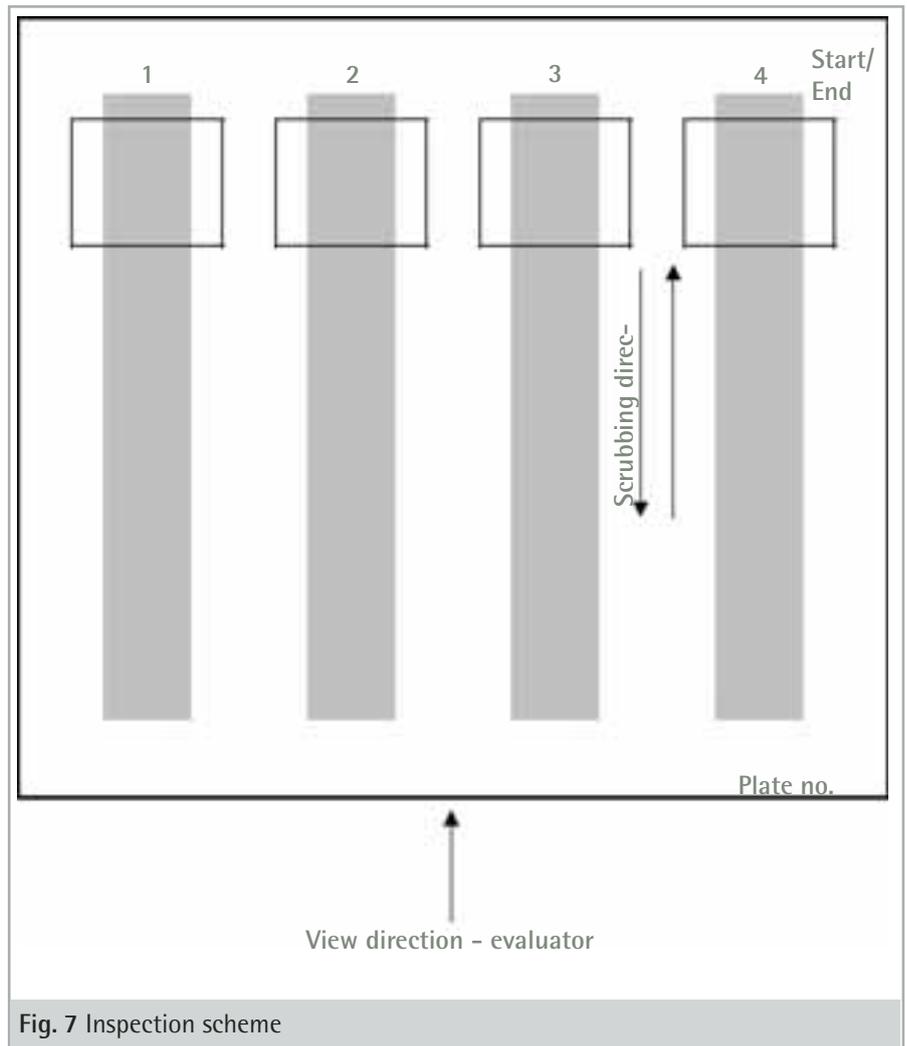


Fig. 7 Inspection scheme

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*Assessment criteria:*

- Streak intensity
- Streak density
- Number of drops
- Size of drops
- Intensity of drops

with an assessment scale ranging from 0 = no residues, 1 = low, 2 = medium, 3 = strong to 4 = very strong. This enables a better differentiation of similar products.

*Assessment of clear drying / streak formation:*

The plates are inspected by at least 3, but preferably 5, experienced persons by way of an independent assessment, with no knowledge of the respective product sample.

*Determination of sequence and significance check*

Regarding assessment, see description under 5a) et seq.

*Description of result for clear drying / streak formation*

The result may be described only in connection with relevant test conditions. Cross-comparisons with grades from different tests are not permissible, unless standardised to water 16.8 od.

**5c) Material care**

Stress cracking corrosion test with small plastic sticks based on German standard DIN 53449 T 1-3 (5).

A non-rusting steel pin (dowel pin DIN 6325 Tol.: m6 3x10) is pressed in test sticks into which a hole has been drilled (drill 2.7 and reamer 2.9 H7), using a device e.g. rack and pinion press type 5 (supply sources d + e). The pin must be inserted vertically.

The test sticks are dipped briefly in the concentrated cleaner to be tested. Adhering cleaner is not removed. Dipping is repeated after 24 hours. Every 24 h the dipping process is repeated on 5 subsequent days, in total 5 dipping processes. The occurrence of stress cracks is evaluated after defined periods of time: 4 hours, 1 day, then every 24 h and documented in tabular form. The test ends after 14 days (see test plan, Annex V).

The following plastics are tested (supply source f):

ABS = Acrylonitrile butadiene styrene  
Novodur P2MC  
PC = Polycarbonate  
Makrolon 3103 FBL 55/115

PMMA= poly methyl methacrylate  
Plexiglas 8N

POM = Polyoxymethylene  
Hostaform 13031 XAS

POM = Polyoxymethylene  
Hostaform C 9021 GV (= glass fibre reinforced) 1/30

The selected materials may undergo changes and can be adapted to new trends. In the following, an explanation of the assessment:

- 1 = No change
- 2 = Start of crack / Small crack
- 3 = Continuous crack
- 4 = Burst

with no knowledge of the respective product sample. The appraisal of material care should be performed and assessed separately for each tested plastic material.

*Description of the result for material care*

The result may be described only in connection with relevant test conditions. Cross-comparisons with grades from different tests are permissible.

**5d) Product characterisation**

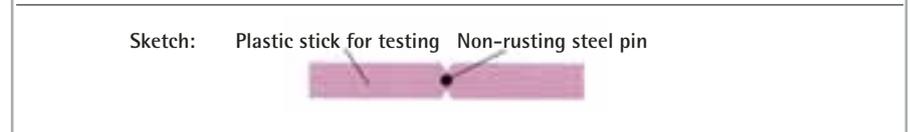
Examination of the product in the state as supplied, in respect of the following attributes:

External condition:  
Organoleptic examination (homogeneous, clear, turbid etc)

Colour:  
Organoleptic examination

Odour:  
Organoleptic examination

Time window	Appraisal	Cleaner
0 - 7 days	1	Recommended
0 - 7 days	2	Suitable with some reservations
0 - 14 days	1	Recommended
0 - 14 days	2	Suitable
At will	3,4	Suitable with some reservations



*Assessment:*

With a recommended cleaner, after 7 or 14 days, respectively, no attack should be visible on the surfaces.

If there are visible traces on the surface, it must be found out whether they can be removed by polishing with a soft cloth. If those traces can be removed with a soft cloth, there is no attack on material.

*Assessment of material care*

Test sticks are inspected, in an independent appraisal, by an experienced person

*Reaction (pH value):*

The pH value is determined using a pH meter at 20 °C in the undiluted form and in the diluted form, as stated by the manufacturer, with fully demineralised water.

The results of the product characterisation are to be listed in a non-judgemental manner, because characteristics are product specific. Only where deviations from the manufacturer's information are found, can this be noted negatively.



Annex to V

		Monday 4h	Tuesday 1	Wednesday 2	Thursday 3	Friday 4	Monday 7	Tuesday 8	Wednesday 9	Thursday 10	Friday 11	Monday 14
H2O	1											
	2											
	3											
	4											
	5											
	6											
Cleaner	1											
	2											
	3											
	4											
	5											
	6											
Cleaner	1											
	2											
	3											
	4											
	5											
	6											

<p>1 Plexiglas                  2 Novodur PL MC                  3 Makrolon PC 3103                  4 Hostaform 13031 AS                  5 Hostaform 9021 GV 1/30                  6 Hostaform 13021</p>	<p>1 - No attack                  2 - Slight cracks                  3 - Continuous crack                  4 - Burst</p>
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## ALL PURPOSE CLEANERS

## Annex to IVa

IKW AK AZR Streakless drying

Evaluation chart for rank scores

Ringtest with 6 products and water on mirrors, visual assessment by ranking.

Only fill-out the yellow area, use rank scores 1 (best) to 4 (worst) per tile.

In case of equal performance divide scores over products

Laboratory:

Date:

Evaluator 1:


Mirror	Track 1		Track 2		Track 3		Track 4		Total rank scores*
	Product	Rank	Product	Rank	Product	Rank	Product	Rank	
1	7		6		5		3		0
2	4		7		6		1		0
3	1		2		7		5		0
4	6		1		3		2		0
5	2		3		4		7		0
6	3		5		1		4		0
7	5		4		2		6		0
8	7		6		5		3		0
9	4		7		6		1		0
10	1		2		7		5		0
11	6		1		3		2		0
12	2		3		4		7		0
13	3		5		1		4		0
14	5		4		2		6		0

\*should add-up to 10 for each separate tile

Total rank scores evaluator 1			
	Mirrors 1 to 7	Mirrors 8 to 14	Total
Product 1	0	0	0
Product 2	0	0	0
Product 3	0	0	0
Product 4	0	0	0
Product 5	0	0	0
Product 6	0	0	0
Product 7	0	0	0
SUM**	0	0	0
**should add up to:	70	70	140

## d) Dowel pin – Zylinderstift DIN 6325

3 x 10 Tol: m6 Article no. 2520310  
 Fa. Würth  
 Postfach  
 74650 Künzelsau, Germany  
 Tel: +49-7940-15-0  
 Fax: +49-7940-15-1000  
 e-mail: info@wuerth.com

## e) Rack and pinion press type 5 – Zahnstangenpresse Typ 5

Schmidt Feintechnik GmbH  
 Feldbergstrasse 1  
 Postfach 14 65  
 78112 St. Georgen /Schwarzwald, Germany  
 Tel: +49-7724 / 89 90  
 Fax: +49-7724 / 89 91 01  
 e-mail: info@schmidt-feintechnik.de

## f) Test plastic sticks –

Kunststoff-Prüfstäbe  
 Kunststofftechnik Buzzi GmbH  
 Vor Heubach 4  
 77761 Schiltach, Germany  
 Tel: +49-7836 / 96 830  
 Fax: +49-7836 / 96 832  
 e-mail: info@kst-buzzi.de

## g) Inputs:

Peanut oil: Mazola:  
 Unilever Deutschland GmbH  
 Rüdiger Ziegler; Dammtorwall 15  
 20355 Hamburg, Germany  
 Tel: +49-40-3993-0 (switchboard)  
 Fax: +49 40-3493-3520

Kaolin 60609

Glutaraldehyde: Fluka:  
 Sigma-Aldrich Chemie GmbH  
 München, Germany  
 Tel: +49 89-6513-0  
 email: deorders@eurnotes.sial.com

Special Black 4 – Spezial Schwarz 4: Degussa  
 Degussa AG  
 Weissfrauenstrasse 9  
 60287 Frankfurt, Germany  
 Tel: +49-69-218-0

Sodium hydroxyde, aqueous solution  
 BASF AG  
 Ludwigshafen, Germany  
 Telefon: +49-621 60-0

Alkybenzene sulfonic acid, C10-13:  
 Impag Import GmbH  
 Fritz-Remy-Strasse 25  
 63071 Offenbach, Germany  
 Tel: +49-69-8500080

Fatty acid C12-18: Edenor K12-18)  
 Fatty alcohol ethoxylate, C12-18, 7 EO:  
 Dehydol LT 7  
 Fatty alcohol ether sulfate, C12-14, 2 EO,  
 Na-salt: Texapon N70:  
 all: Cognis Deutschland GmbH & Co KG  
 Postfach 13 01 64  
 40551 Düsseldorf, Germany  
 Tel: +49-211-7940 0

## h) Floor tile – Fußbodenfliese Villeroy +

Boch 3135, 30 x 30 cm:  
 Villeroy & Boch AG  
 Hauptverwaltung  
 Postfach 1120  
 66688 Mettlach, Germany  
 Tel. +49-6864-81-0

## i) Mirror tile –

Spiegelfliese 30 x 30 cm:  
 Do-it-yourself store quality

## Literature: Sources

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- (2) Seifen, Öle, Fette, Wachse,  
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