FRT guidelines

The correct approach to

the reprocessing of

cleaning textiles

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C O N T E N T S

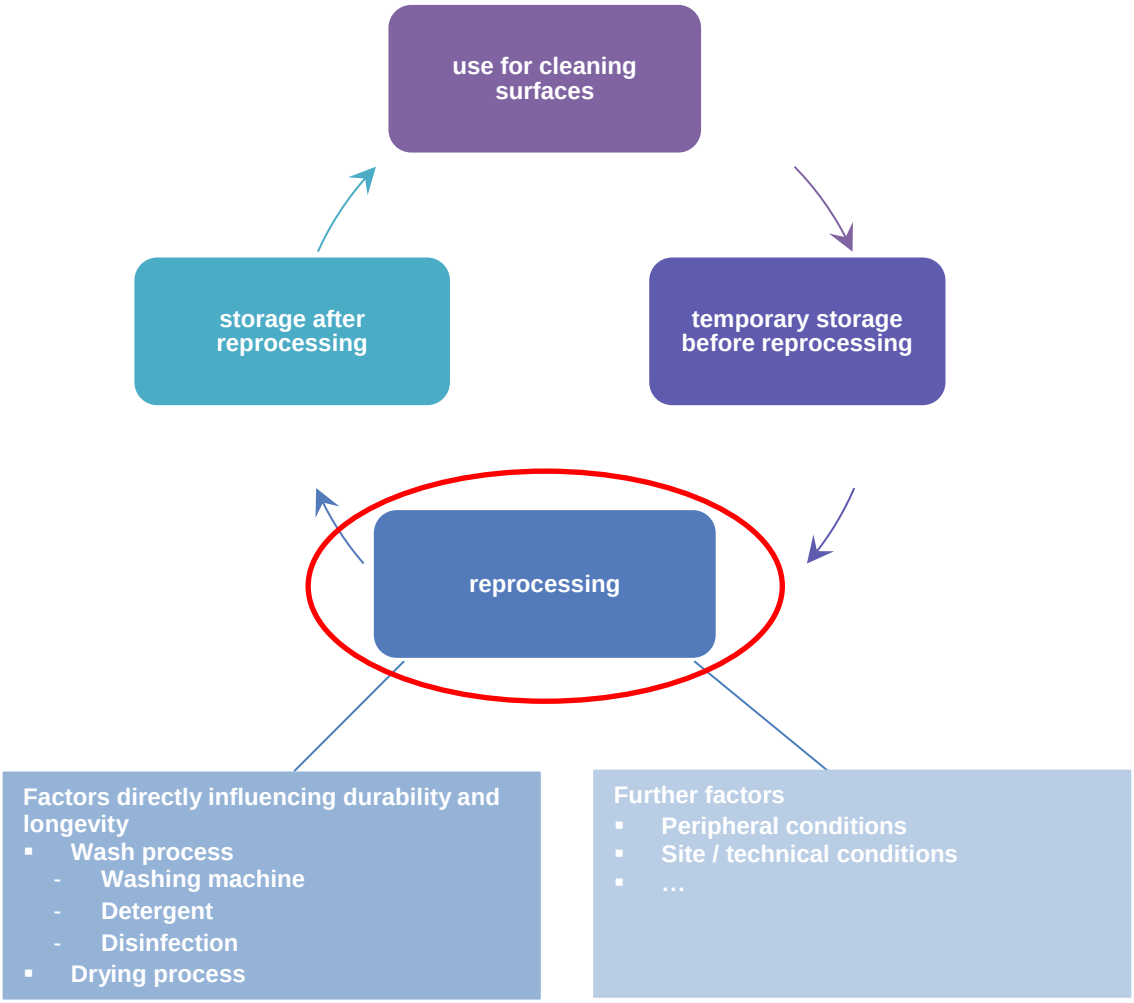
Introduction

The reprocessing of cleaning textiles, i.e. flat mops, cleaning cloths etc., plays a significant role in professional cleaning and care. Only technically intact and clean textiles can guarantee proper cleaning and care and produce results which are satisfactory to all concerned.

One has to bear in mind that modern cleaning textiles are technical products that require special and over all mandatory cleaning and care measures. Still, though, conventional washing processes are used, be it as the result of a lack of knowledge or a sense of false economy. This results in insufficiently "clean" textiles and a reduction in the durability of textiles. In the worst case, the quality of cleaning with these textiles is impaired. Particularly when reprocessing cleaning textiles for use in areas where hygiene is critical, suitable measures must be in place to ensure proper hygiene.

The industry has therefore committed to the goal of scrutinizing all the parameters which influence reprocessing and to issuing reprocessing recommendations aimed at extending the useful life of cleaning textiles without neglecting quality or hygiene issues. These guidelines therefore address all persons involved in the reprocessing of cleaning textiles, whether as user or decision-maker.

Essentially, all stages within the usage cycle, i.e. from using cleaning textiles to storage and reprocessing, have an impact on the durability of textiles.



In addition to the actual use of cleaning textiles, reprocessing in the washing and drying process accounts for most of the wear and tear on fabrics and is therefore addressed in particular detail in these guidelines. These guidelines are subdivided into three parts.

1. Brief instructions
2. Reprocessing recommendations
3. Appendices

The first part comprises two short instructions, one each for areas where hygiene is critical and non-critical respectively. These instructions describe the main stages of washing and drying process. Included is a brief explanation in the form of two concise tables. These short instructions can be posted on site, either on or next to the machines, to provide on-the-job assistance. More thorough and detailed reprocessing information is provided in part 2. The appendices in part 3 are a source of further information on, for example, hygiene and occupational safety, as well as relevant further reading references.

The reprocessing and care recommendations for cleaning textiles in this guideline are based on state-of-the-art technology and on the practical experience of the persons who contributed to this guideline.

Contributors to this factsheet include experts from among the manufacturers of cleaning textiles, detergents and care products, cleaning equipment, washing machines and tumble dryers as well as contract cleaners and the wfk - Cleaning Technology Institute. This factsheet reflects currently recognized standards of good practice.

All information has been compiled with due care by members of the working group; nevertheless, it can only contain general points and recommendations. Maintaining the correct procedure in selecting cleaning textiles, detergents, washing machines and tumble dryers and in performing proper reprocessing, hygiene and care measures remains the responsibility of planners and the companies involved. In addition, instructions and recommendations issued by the relevant manufacturers (technical datasheets, product information bulletins, safety datasheets etc.) also have to be considered.

This document together with further material can be ordered from the FRT office. Further important information is also available, e.g. on maintaining the value of floor coverings (all material German language only). A full list of available factsheets is provided by Appendix 9 "FRT factsheets and leaflets".

Krefeld, 31.08.2014

Part 1:

Brief instructions

The greatest risk of damage to cleaning textiles, decreasing their useful life, is by far incorrect reprocessing.

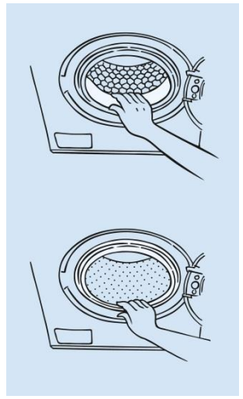
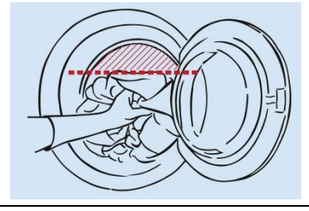
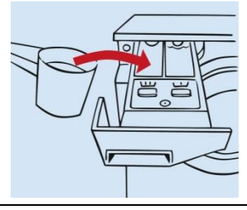
Often, the washing process and its influences on the durability of mops and cleaning cloths are underestimated. This can rapidly result in damaged textiles and, by consequence, major cost disadvantages.

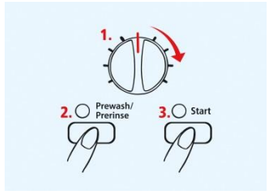
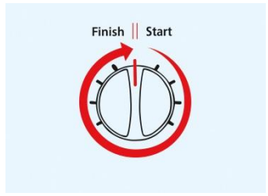
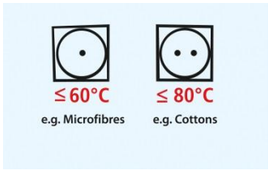
These guidelines are intended to promote the longevity of cleaning textiles by paying greater attention to optimization of processes with respect to cleanliness and hygiene.

It is recommended to implement processes according to the rules of quality management in order to ensure reproducible reprocessing results.

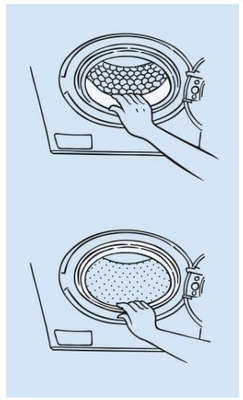
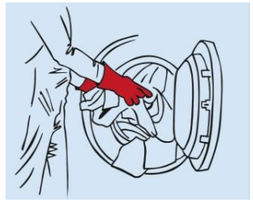
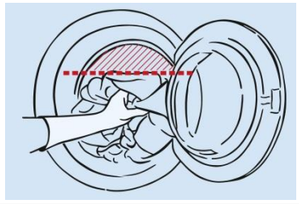
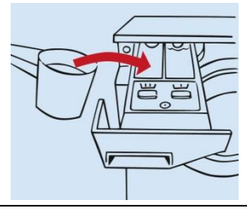
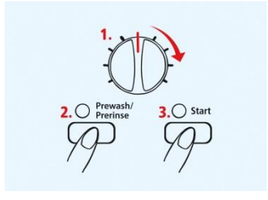
In the following section, the main process stages of the washing and drying cycles are presented in two short tables, one each for areas with and without hygiene relevance.

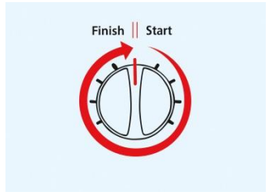
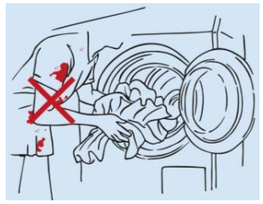
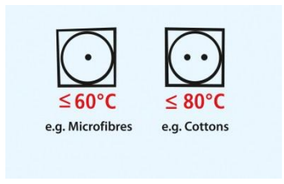
These tables present examples which, adapted to on-site requirements, can be posted on or near a washing machine or tumble dryer for reference. The choice of a simple method of representation was deliberate and is further supported by icons which help identifying "right" from "wrong" methods in each case. This is to ensure that machine operators are instructed in the correct methods without much effort or reading.

Table 1a: Hygienically non-critical areas			
	Icon	**Explanation**	**Information specific to site***
Inspection of washing machine		Visual inspection of water inlet and drainage systems. Removal of soil and foreign objects from drum, door gasket and detergent dispenser.	
Removal of coarse soil		Shake out mops: Remove coarse soil which could damage both the machine and textiles and impair wash results.	
Separation of textiles		Separation of cotton and microfiber textiles. Where possible, cleaning textiles should be sorted by color before washing.	
Correct loading		Do not overload machines in order to avoid impaired wash results and damage to the machine. All items must be clear of the door gasket before closing the machine door.	
Correct detergent / correct dispensing		Pour the correct amount of the right product into the correct compartment of the detergent dispenser (for the main wash) or use an automatic dispensing system. Only use a disinfecting wash cycle when required.	

Correct wash cycle (incl. temperature)		A pre-rinse cycle (with fresh water) should be performed in order to remove any detergent and disinfectant residues. To avoid damage to textiles, do not run **higher temperatures** than recommended by detergent manufacturers.	
Run cycle		Terminating a program prematurely results in poorer cleaning results and possible damage to textiles.	
Use textiles immediately or store dry		To prevent any growth of bacteria, textiles should be used immediately or dried in a tumble dryer and then stored in a dry place.	
Sorting and drying		Do not dry microfibers and cotton textiles in the same cycle.	
Correct drying temperature		Never dry microfibers at temperatures above 60 °C, measured in the load. Cotton items are able to tolerate a maximum temperature of 80 °C. Drying times depend on residual moisture content (microfiber = low, cotton = high).	

* Complete as required. Adjust to specific on-site conditions.

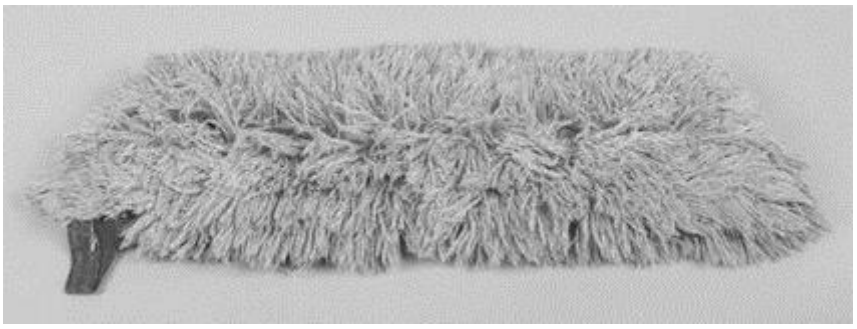
Table 1b: Hygienically critical areas (Note Appendix 2)			
	Icon	**Explanation**	**Information specific to site***
Inspect washing machine		Visual inspection of water inlet and drainage systems. Removal of soiling/foreign objects from drum, door gasket and detergent dispenser.	
Wear protective clothing		Wear protective clothing suitable for work in unclean area.	
Correct loading		Do not overload the machine in order to avoid poor wash results and damage to the machine. Ensure that all items are clear of the door gasket before closing the door. Disinfect hands after removing protective gloves.	
Correct detergent / correct dispensing		Pour the correct amount of the right product into the correct compartment of the detergent dispenser (for the main wash) or use an automatic dispensing system.	
Correct wash cycle (incl. temperature)		Select a disinfection cycle	

Disinfect machine front and loading equipment		Single-door machines: door hatch and front-side of the machine have to be properly disinfected after every loading of machine (cf. hygiene plan). On pass-through machines (with separate doors on the loading and unloading sides), disinfection should be performed in accordance with the hygiene plan.	
Run cycle		Premature termination of a disinfection cycle is not allowed and results in an intolerable level of bacterial contamination.	
Wear clean work clothing		Wear clean work wear when entering the clean area and disinfect your hands.	
Correct unloading		Avoid any recontamination of cleaning textiles during unloading. Use only suitable transport containers.	
Dry items immediately		Dry mops immediately in a tumble dryer without any intermediate storage in damp state.	
Correct drying temperature		Never dry microfibers at temperatures above 60 °C, measured in the load. Cotton items are able to tolerate a maximum temperature of 80 °C. Drying times depend on residual moisture content (microfiber = low, cotton = high).	
Further processing/ Storage		It is important to avoid any risk of bacterial recontamination when processing or storing cleaning textiles, cf. hygiene plan.	

* Complete as required. Adjust to specific on-site conditions.

Part 2:

Reprocessing recommendations



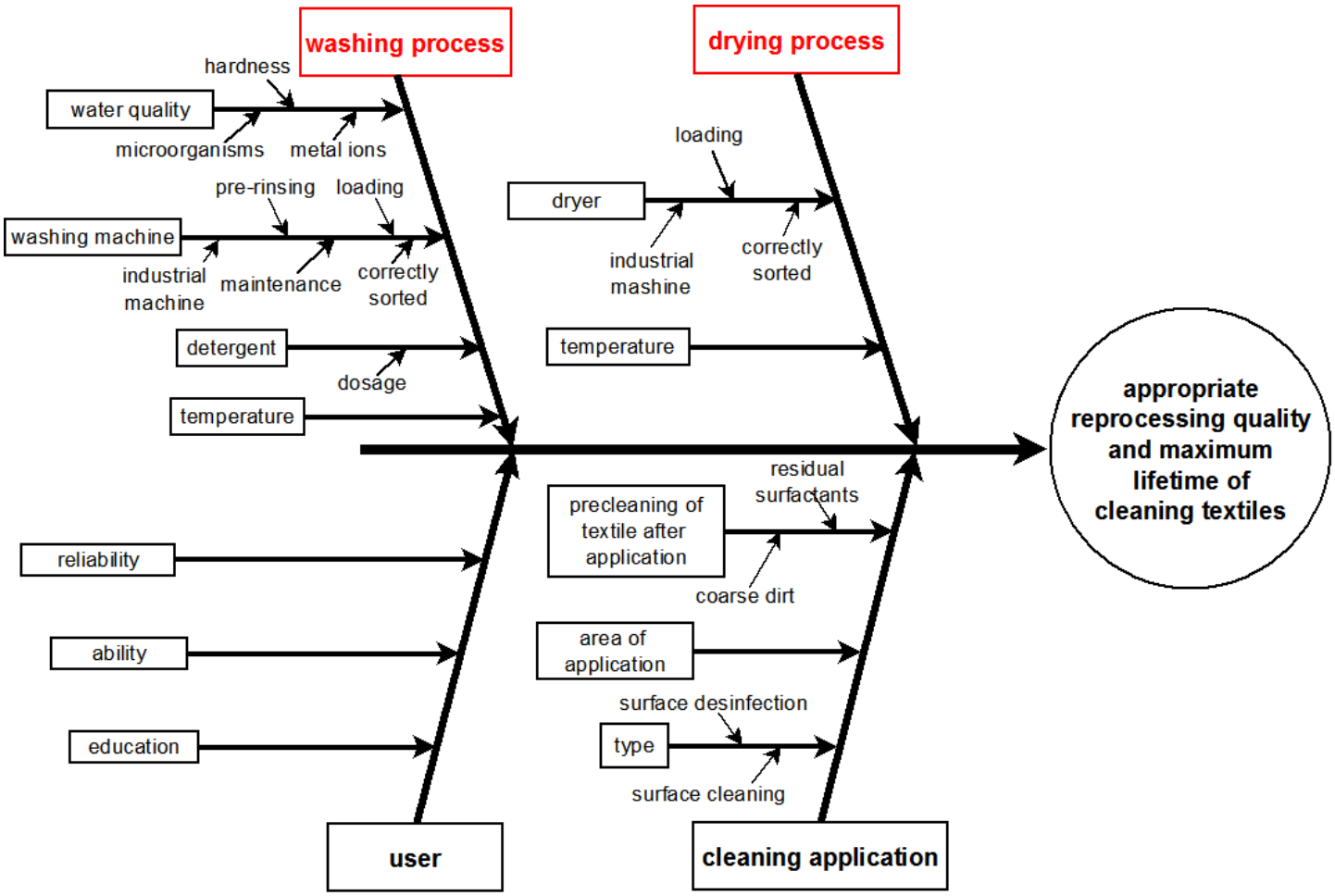
Washed 600x under "ideal" conditions …

The same mop:

Washed 600x under "unfavorable" conditions …

If your cleaning textiles look like in the bottom image, it is high time to review your reprocessing method! The following section shows how this is done best:

The following section of the guideline presents the aspects which are key to proper reprocessing and hence achieving good reprocessing quality whilst at the same time maximizing the durability of cleaning textiles. The maximum useful life of cleaning textiles is dependent on several factors. The following chart (Ishikawa cause-and-effect diagram) lists the main influences on the various sub-processes. The core is formed by the washing process, the drying process, the user and the cleaning application itself.



The factors "**Washing Process**" and "**Drying process**" are covered more in-depth in course of this guideline. This does not mean, however, that the factors *"User"* and *"Application"* do not have any or only slight impact on the reprocessing results. In the end, it is the user who carries out the reprocessing and therefore is responsible for implementing all recommendations. But also the type of use of the cleaning textiles can influence their durability to a considerable degree. The use, for example, of flat mops on slip-resistant floorings often results in mechanical damage to the textiles. In such a case, the "correct" reprocessing is not able to prolong the life cycle.

Precise notes and practical instructions have been provided throughout. Readers interested in further details and background information on the subject of damage to textiles are referred to Appendix 1 in Part 3.

Quality assurance:

In order to ensure consistency in the quality of reprocessing as well as a uniform, repeatable processes, it is recommendable to install a quality management system (e.g. DIN EN ISO 9000 ff [1]) or, in the case of processes with hygienic relevance, a hygiene management system (e.g. DIN EN 14065 [2]) (cf. Appendix 2).

Before first use:

- In case not performed by the manufacturer, mops and cleaning cloths should **be pre-washed before first use** (sorted according to color in the case of cloths) so as to remove any chemicals used in the production process and to ensure that fabrics have their full absorbance capacity. In the case of mops, a correct fit is achieved through the shrinkage which occurs during washing. During this pre-washing, it is important not to exceed the **maximum wash temperatures** as recommended by manufacturers. Further information can be obtained from manufacturers, their agents or from technical literature accompanying the products.

Preparatory steps before washing:

- **Check washing machine**: A properly functioning washing machine is key to wash performance. The following should be routinely checked:
    - Waste water hose: Ensure that hose is never kinked or compressed. Check whether water is discharged at a level which is higher than the washing machine itself.
    - Drum: Check for visible damage or soiling; if needed repair or clean
    - Detergent dispenser: Check for soiling and remove any powder residues
    - Check all possible filters in water inlet and drainage system and clean as necessary
- **Sort textiles**: By textile type (clear separation of different fabric types in order to avoid linting), by degree of soiling and, in the case of cloths, by color (dark items may bleed and discolor lighter colored textiles).
- **Remove coarse soil** before washing (e.g. shake, beat, brush etc.).
- **Never wash together with abrasive materials**, e.g. scouring mops, other abrasive materials.

When reprocessing **cleaning textiles used in hygienically critical areas**, the sorting of textiles, the removal of coarse soil and the inspection of textiles cannot be carried out without additional occupational safety and hygiene measures (cf. Appendix 2).

The washing process:

- In the case of cleaning textiles, correct processes can generally only be ensured through the use of commercial washing machines; **domestic washing machines are unsuitable (cf. Appendix 4).**

- Load **the washing machine, avoiding overloading.**

  Overloading impairs wash performance. Mops are not properly cleaned and, together with detergent residues, this will lead to a reduction in floor cleaning performance.

  Wash performance relies heavily on laundry being able to tumble freely in the rotating drum. This ability to move depends above all on the volume of laundry and the capacity of the drum. The general rule of thumb which says that "an upright opened hand should fit above the top of the load" can only be applied to small washing machines. It makes more sense to check which maximum load size still allows cleaning textiles to tumble freely from the 11 o'clock position of the drum. The height of the load can then be marked (using for example tape attached to the machine). Alternatively, the correct load size can be determined by weighing or counting items.

  Free moving space is also severely restricted in overfilled laundry nets. Hence, these should only be 30% full with cotton items and 50% filled with micro-fibers.

  When loading washing machines with **cleaning textiles from areas of hygienic relevance**, it is important to observe all relevant occupational safety and hygiene regulations (cf. Appendix 2).

- **Select the correct wash cycle** (pre-wash, main wash, load-to-liquor ratio, temperature, rinse and spin cycles, disinfection). Depending on the machine type, these wash programs may be pre-installed or may have to be programmed in according to individual requirements. The wash program is governed by the type of textiles being washed, the degree of soiling and the conditions under which the cleaning textiles are used (e.g. hygienically relevant areas).

  Additional rinse and spin cycles: Especially damp or wet cleaning textiles should be dewatered with an additional spin cycle prior to a pre-wash (all relevant national and local regulations covering the discharge of effluent into the sewage system should be observed, e.g., municipal sewage regulations, leaflets DWA-M 115-1 [3], DWA-M 115-2 [4], and DWA-M 775 [5], and the regulations specified there). Removing dirt water from the cleaning textiles already removes a part of the soil before the wash cycle commences. In addition more fresh water can flow into the machine without changing the overall water level. Thereby a second pre-rinse may be skipped, additionally saving water.

  If disinfectants or a combination of different chemicals are used to clean surfaces, it is important that any such residues are removed from the cleaning textiles before the main wash. Similarly, detergent residues from the main wash should be removed in a

subsequent interim spin cycle followed by rinsing. This avoids virtually all unwantted interactions between surface cleaning detergents, disinfectants and laundry detergents. Residues from laundry detergents, surface cleaning agents and disinfectants in cleaning textiles and above all their reactions may considerably impair the cleaning performance of the textiles and may even damage the materials used within the cleaning textiles.

Where possible, wash temperatures above 60 °C should be avoided when washing cleaning textiles from areas without hygienic relevance. Higher temperatures are possible but generally result in increased strain on textiles and fibers. Increased lime deposits on machine components and textiles which occur at temperatures in excess of 60 °C are also reduced. Lower temperatures thereby help save energy in the washing process and reduce the strain on machines and textiles.

Cleaning textiles from hygienically critical areas must be reprocessed with a disinfecting washing method (cf. Appendix 2). But it is important to refrain from using chlorine.

- Select **suitable detergents/disinfectants** according to type of textile, nature of soiling and instructions issued by both the manufacturers of the textiles and chemicals. Dose products properly (note degree of soiling, water hardness and load size as explained above). Refer to technical information provided by the manufacturer of chemicals for dosing amounts according to degree of soiling and water hardness.

  Overdosage of detergent can result in detergent residues in textiles. This reduces the absorbency of the textiles and, in combination with surface disinfectants, may result in unwanted reactions during cleaning (soap error). Excessive overdosage of detergent can also result in pH values > 11 which are potentially damaging to fabrics. Overdosing disinfectants during reprocessing may result in damage to cleaning textiles.

  Underdosage, on the other hand, results in poor wash performance (soil residues) and in an accumulation of limescale in the cleaning textiles. This also results in a loss in absorbency, in textiles becoming brittle on account of calcareous deposits, in damage to fabrics (substrate material and/or loops/pile) and the disintegration of seams. Underdosing disinfectant can result in an insufficient germ reduction.

  In case of poor wash results or damage to fabrics or fibers, suitable test fabrics can be added to the wash load. Evaluating the results after washing provides information on whiteness, redeposition, ash content and tensile strength.

  Depending on the desired washing results, adjustments can be made to the detergent dosage.

Only add detergent to the main wash and not to the pre-wash. Residues from cationic surfactants, for example from surface disinfectants, may otherwise react with anionic surfactants contained in laundry detergents to form insoluble compounds, causing fibers to stick together.

Appendix 3 lists several important parameters for various washing processes considering the above mentioned points.

After the wash process:

- Remove **moist cleaning textiles** for areas without hygienic relevance from the washing machine and use immediately or machine-dry if storage is likely to exceed 2 hours. Appendix 2 applies to wet cleaning textiles for hygienically relevant areas.

- **Textiles impregnated with detergents during reprocessing** should be used without delay, whereas cleaning textiles impregnated with disinfectant under certain conditions should not be stored for longer than 1 day (cf. Appendix 2); in cases where hygiene is particularly important, the duration of storage should be evaluated using swab tests.

- The **washing machine drum**, the **door gasket** and the **detergent dispenser** should be inspected immediately after the wash cycle for soiling and cleaned as appropriate. The rubber gaskets should be checked, cleaned and disinfected before unloading textiles for use in hygienically critical areas in order to prevent any recontamination of reprocessed textiles. Further suitable measures are covered in Appendix 2.

- **Drying**: Where possible, dry different types of textiles separately (instructions on label or in documentation provided by textile manufacturers); never exceed the maximum permissible surface temperature (overdrying) as this may result in thermal damage. Always follow the care instructions provided by textile manufacturers.

- Cleaning textiles should be **stored in a dry place**. Storage under damp conditions may result in considerable bacterial growth. Alongside mildew stains on textiles, this also results in the contamination of the surfaces to be cleaned. Consequently, cleaning textiles contaminated with mildew stains should be disposed of.

Additional notes:

- Special attention should be paid to water quality: Very hard water, especially in combination with underdosage of detergent, can result in lime deposits. This eventually leads to the substrate of mops becoming harsh and brittle.

- Iron and other heavy metals (e.g. copper, manganese) in the wash water can result in local and sudden decomposition of bleach, causing rapid damage to textiles. The following limits should therefore apply:

    - Iron < 0.1 mg/l
    - Manganese < 0.03 mg/l
    - Copper < 0.05 mg/l

- Do not use fabric conditioners.

- Clean rooms require suitable cleaning textiles and special washing processes.

- It is recommended that washing machine service intervals should be carefully observed. This involves, for instance, regularly checking components prone to failure, e.g. heater elements.

- If washing regularly takes place at low temperatures without disinfection, both the machine and mops should be subjected to a thermal or chemo-thermal washing cycle. Alternative measures can also be taken to prevent bacterial contamination or formation of malodors.

For the correct reprocessing of cleaning textiles and therefore in the interest of material longevity, general conditions in the direct surrounding of the washing machine and tumble dryer are also important. Cleaning these areas should also take place at regular intervals. Appendix 2 provides information on cleaning textiles for areas of hygienic relevance.

Part 3:

Appendices

Appendix 1: Damage to textiles: Detailed information

Impact of reprocessing on mops:

160 g	**new: 150 g**	**95 g**
Greying, sticking and weight increase because of build-up of cation-anion complexes.	New condition	Destruction due to hydrolysis at excessively high drying temperatures

Reasons for premature wear and tear:

Cleaning textiles are primarily damaged by physical (temperature, mechanical forces etc.) or chemical factors. These can occur both during reprocessing (in the washing machine or tumble dryer) and during use. Furthermore, the intercalation of unwanted substances (calcium carbonate, lime soap, soil etc.) can lead to premature wear and tear. The following part describes several of these factors in detail with respect to their causes and effects.

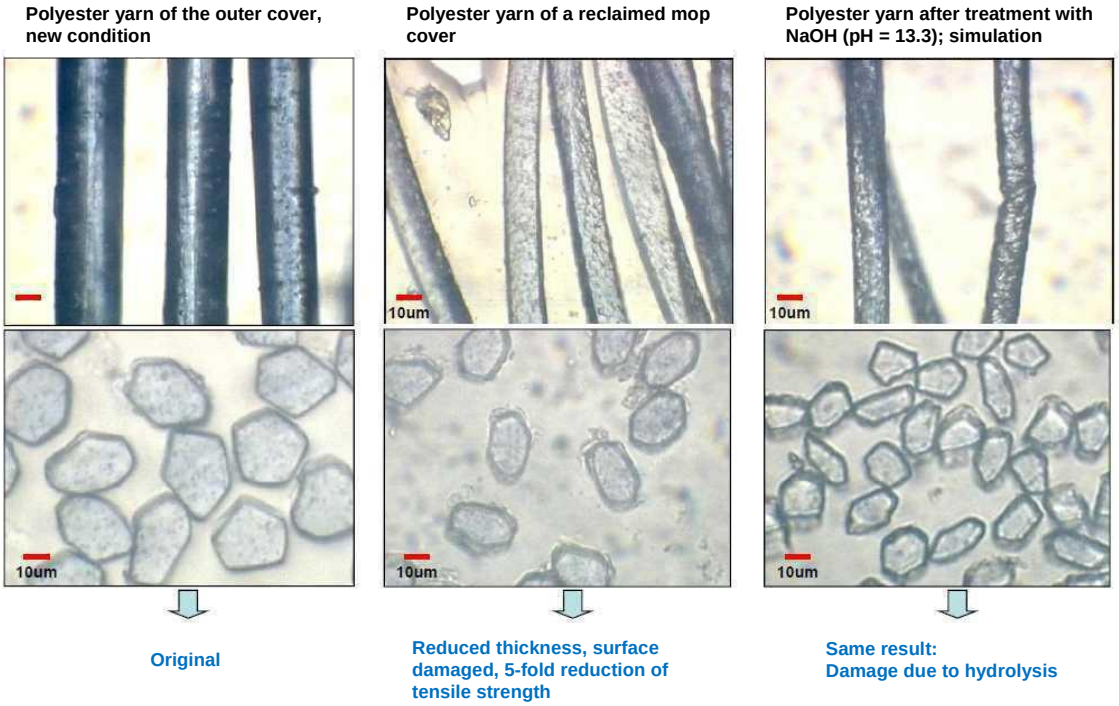
1 Physical / chemical destruction

Two effects are mainly responsible for the physical and chemical destruction of cleaning textiles:

- Hydrolysis:

Hydrolysis is the cleavage of a chemical compound with the addition of a water molecule.

The hydrolysis reaction and thus the cleavage also can affect the threads used in the manufacturing of mops, causing irreversible damage like weight loss and thereby material fatigue.



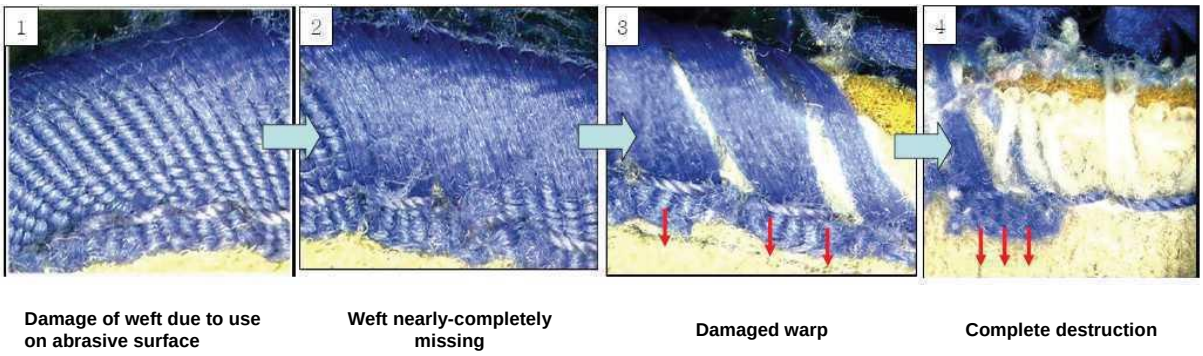
Especially synthetic fibers made from polyester (PES) are susceptible to hydrolysis caused by excessively high pH from alkalis, whereas cotton (CO) or viscose (CV) are reasonably stable to alkalis.

Reasons for hydrolysis:

- High alkalinity (pH > 11), especially in combination with high temperatures

- Mechanical damage of textiles

Mechanical forces, e.g. friction, compression, temperature etc., result in weakening of fibers respectively change in shape of fabrics (breakage or tearing of fibers, shrinkage, melting etc.) up to to the complete loss of substance (abrasion). Damage to the upper material may, in turn, result in further damage to the substrate and, eventually, the complete disintegration of the cleaning textile.



Example: Abrasive damage at seam of a floor mop

The first indication of the (always happening) mechanical action on fibers is the greying of cleaning textiles. The clean mop appears macroscopically to be "grey." Under a microscope, however, the fibers are white and compared with a new mop are spliced. This type of greying is a purely optical effect. This process normally cannot be avoided and has initially no detrimental impact on the cleaning performance of the textile. Only when the mechanical influence is getting stronger the damages described above will occur.

Both hydrolysis and mechanical damage of textiles also can be noticed by a **loss in weight**. This weakening of the fabric and the loss of substance results in severely reduced cleaning performance (too few or too thin fibers) and a reduced ability to absorb liquids or pick up soil.

Similarly, **shrinkage of the sheet and/or the loop-pile material** as a result of excessively high temperatures is a clear indication of such physical and chemical damage of the cleaning textiles. Such changes to shape also impair proper cleaning.

As described in the introduction, there are several places where damage by physical or chemical factors can take place:

- Washing machine
- Tumble dryer
- During use

1.1 Physical / chemical destruction in washing machine

Caused by:

- Washing at temperatures > 90°C with chemo-thermal disinfectants
- Too low water level
- Excessive use of detergent/disinfectant/bleach
- Too high wash temperature (with respect to temperature stability of the material: care instructions)
- Addition of chlorine bleach
- Poor sorting of items (cross-damage)
- Insufficient removal of coarse soil before main wash (sand, grit etc.)
- Damaged drum

1.2 Physical / chemical destruction in tumble dryer

Caused by:

- Too high temperatures during drying process (> 60°C measured on microfibers and > 80°C on cottons), especially when using dryers without infrared sensors (to measure load temperature) because of the risk of over-drying.
- Bleach and disinfectant residues in insufficiently rinsed mops

1.3 Physical / chemical destruction during use

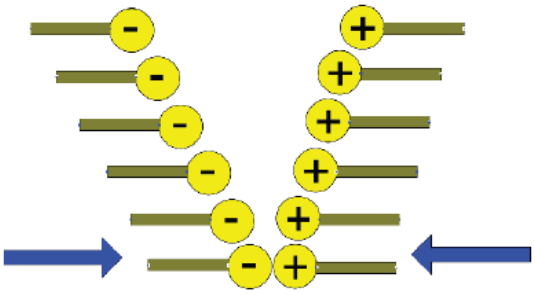
Caused by:

- Cleaning of anti-slip floorings or rough surfaces can result in higher mechanical strain

2 Intercalation of unwanted substances

2.1 Cation-anion reaction

Negatively charged anionic surfactants (usually from laundry detergents or surface cleaning agents) can react with positively charged cationic surfactants (usually from surface disinfectants) to form high-molecular weight organic salts.



These mostly water-insoluble compounds accumulate in the cleaning textiles and very often cannot be removed by washing.

These compounds are mainly caused by:

- the use of laundry detergent (anionic surfactants) in the pre-wash when surface disinfectant residues (cationic surfactants) are still present in the cleaning textiles;
- the omission of a pre-wash cycle, above all when there are still residues of cationic surfactants from disinfectants in the load;
- an insufficient number of rinse cycles or the use of too little water. This can cause residues of anionic surfactants in the cleaning textiles which then in turn react with cationic surfactants from surface disinfectants (soap error: reduction or even complete loss of disinfection efficiency on surfaces cleaned);
- unduly mixing of laundry detergents and disinfectants.

This results in:

- “clogging” of fibers (mop “smears”)
- reduced ability to absorb liquids and pick up soil (reduced cleaning performance):
- weight increase (up to 50 g/mop!);
- greying of textiles (does not in itself influence cleaning performance, but adds to the perception of poor cleaning, above all in areas where hygiene is critical).

2.2 Limescale and lime soaps

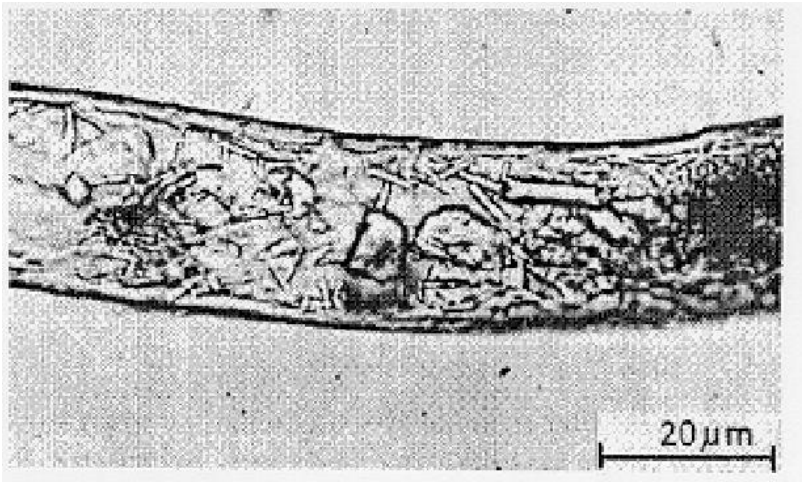
Limescale and lime soaps are the result of underdosage of laundry detergent during the reprocessing of cleaning textiles. THis leads to hardness minerals from (hard) water (calcium and magnesium bicarbonates or calcium or magnesium sulfates, chlorides and nitrates) being insufficiently removed during the wash cycle. At temperatures above 60 °C, these minerals either precipitate from solution as limescale (furring, calcareous deposits, inorganic encrustations) or react with the soaps contained in detergents (usually fatty acids) to form lime soaps (organic encrustation):

$Ca(HCO_3)_2 \rightarrow \mathbf{CaCO_3}\downarrow + H_2O + CO_2\uparrow$ (formation of lime from calcium hydrogen carbonate)

$2\ R\text{-}COO^- + Ca^{2+} \rightarrow \mathbf{(R\text{-}COO)_2Ca}\downarrow$ (creation of lime soap from a fatty acid)

This results in:

- hardening of fibers (impaired cleaning performance);
- breakage of seams (irreversible damage to textile);
- “clogging” of fibers (mop “smears”);
- reduced ability to absorb liquids and pick up soil (reduced cleaning performance);
- weight increase.



For this reason, soap is rarely used in modern detergents. Instead surfactants which are not sensitive to water hardness are applied. Lime soap can also be formed when soap cleansers are used in hard water.

2.3 Zeolite residue

Zeolites (mainly zeolite A) are particularly used in non-commercial laundry detergents as so-called builders to remove calcium and magnesium ions (water hardness). They are water-insoluble.

Zeolite residues are caused by:

- overdosage of laundry detergents;
- excesive use of water softeners;
- insufficient rinsing during reprocessing.

In addition to a weight increase of the cleaning textile, zeolites can deposit on the surface as unwanted residues during cleaning.

2.4 Dirt residues

Due to the inadequately removal of dirt before or during the reprocessing of the cleaning textiles, dirt residues can remain in the textile. Main reasons for this problem mainly include the following points:

- Inadequate shake out of mops before washing;
- Overfilling the washing machine, i.e. not observing the filling ratio;
- A shortening of the wash cycle because of:
    - too short main wash duration,
    - missing pre-wash cycle,
    - missing intermediate spinning between pre-wash and main wash;
- The water level being too low;
- An underdosage of laundry detergent or using a "wrong" detergent.

Dirt residues in the cleaning textiles generally lead to the following:

- A reduction in the cleaning performance;
- Possible damage to the care film (if present) or - in case of long-term use - to the surface in case of abrasive residues;
- Greying of cleaning textile;
- Weight increase.

2.5 Foreign fibers

When washing or drying items of different type, cellulose fibers from cotton or viscose textiles created by pilling effects are incorporated into microfiber yarn structure.

This effect reduces the cleaning performance (mechanical cleaning performance and streak-free wiping) of microfiber textiles.

Appendix 2: Reprocessing of cleaning textiles from an hygienic viewpoint

If cleaning textiles are used in hygienically relevant areas, such as:

- Hospitals
- Nursing homes
- Food processing industry etc.

hygienic requirements are placed on the reprocessing and on the products being reprocessed.

On the one hand, microorganisms adhered to the cleaning textiles must – in the interest of infection prevention – be safely killed or deactivated and a recontamination must be prevented. On the other hand, after reprocessing the cleaning textiles must possess quality properties that do not impair surface disinfection performed with the cleaning textiles. This chapter only partially covers the question about required protective equipment for workers handling cleaning textiles that contain infectious or potentially infections biomaterials. In addition, in individual cases a risk assessment according to BioStoffV (German Biomaterial Regulation) [6] as well as the valid regulations and recommendations of, for example, the employer's liability insurance associations [7] have to be carried out and observed.

To guarantee the certain killing of all pathogens adhering to the cleaning textiles, the cleaning textiles must be disinfected. Suitable disinfection washing methods, for example, can be found in the disinfectant lists of the Verbund für Angewandte Hygiene (VAH) (Association for Applied Hygiene) [8] or the Robert-Koch-Institut (RKI) [9]. These lists contain information on the processing parameters of suitable washing methods, including the specified detergent products that show a sufficient disinfection effect. The parameters listed include: dosage of the products, disinfection temperature, holding time of the disinfection temperature, and the suds ratio. It is mandatory that the parameters specified in these disinfectant lists are observed in practice.

At least once a year, the disinfection performance of the washing methods used to disinfect cleaning textiles must be validated, i.e. tested [10]. For this purpose, special bioindicators consisting of test germs (usually *S. aureus* and *E. faecium*) and cotton textile samples contaminated with defibrinated sheep's blood are washed together with the wash load (e.g. DesVali W3). Biomonitors with a semipermeable membrane are not suitable [10]. A successful disinfection is assumed if the germ reduction factor determined using the bioindicators is > 7 $\log_{10}$ levels [10]. Basically, it is also possible to disinfect cleaning textiles using washing methods that are not listed in the disinfectant lists mentioned above. In that case however, it is necessary for the machine owner to set the process parameters and to guarantee and specify the safety of the method used. To guarantee the quality properties of cleaning textiles that do not impair a subsequent disinfection performance during use, relevant quality properties of cleaning textiles must be taken into consideration: the hygienic state of the textiles, residual content of organic soiling in the cleaning textiles, and residual moisture.

In addition to proper disinfection, a recontamination of the reprocessed cleaning textiles must be minimized using suitable measures. This includes technical, organizational, and personal measures. The measures to be implemented depend on the requirements and on-site situation and must always be considered individually. The following list is thus only exemplary:

- Separation into non-clean and clean areas, either by physical or organizational measures.
- If a physical separation exists, the washing machines should be designed as pass-through machines with a separate loading and unloading opening. Some disinfection measures and occupational safety precautions can then be adapted accordingly, e.g. disinfection of the machine front.
- Personnel should wear different work clothing (e.g. differentiable color) for clean and non-clean areas. If the personnel have to move from the non-clean to the clean area, they must disinfect their hands and change their work clothing. If a physical separation is present, personnel airlocks are recommended.
- The personnel must be trained on a regular basis (e.g. annually) about the content of the hygiene plan. The instructor must have sufficient knowledge and obtain it through further training if necessary, e.g. in regard to good hygiene practice for building cleaners.
- All hygiene-related activities should be recorded in the hygiene plan.
- Surfaces that come into contact with the cleaning textiles must be disinfected regularly.
- After washing, the cleaning textiles must not be intermediately stored and should be completely dried immediately after washing.
- When storing cleaning textiles, recontamination must be prevented by suitable measures (e.g. suitable packaging).

Information for the healthcare sector is provided in the RKI recommendation "Anforderungen an die Hygiene bei der Reinigung und Desinfektion von Flächen" (Hygiene requirements for the cleaning and disinfection of surfaces) [11]. The first source of recontamination after disinfection is the rinsing water; additional sources could include surfaces, the hands of personnel, and contaminated machines. It is thus important that the risk of recontamination at these sources is minimized and microbiologically tested regularly, usually annually. Microbiological limits and reference values for these measuring parameters can be found in the table below (also see the testing requirements of the “wfk Siegel für Textilhygiene” (wfk Seal for Textile Hygiene) for the cleaning textiles subsection [12]).

Recontamination sources: Microbiological limits and reference values [12]	
Measuring parameters	**Limit/reference value**
Disinfection performance of washing method	Reduction factor 7 $\log_{10}$ levels [a]
Reprocessed cleaning textiles (dried)	20 CFU/dm^2 [bc]
Moist cleaning textiles according to washing method	30 CFU/dm^2 [b]
Surfaces in the vicinity of the laundry	100 CFU/dm^2 [b]
Hands of the personnel	100 CFU/dm^2 [b]

a = Bioindicator measuring method
b = Plate sampling measuring method (RODAC)
c = In 9 out of 10 samples and the absence of human pathogens

All cleaning and disinfection measures that influence the ambient conditions during reprocessing should be documented in a hygiene plan. It is recommended that checklists for monitoring the performance of the measures from the hygiene plan are used. At least once a year, the personnel participating in the reprocessing of the cleaning textiles must be trained about the hygienic risks and special features of reprocessing cleaning textiles. Additionally, general measures for hygienic reprocessing, for example, professional maintenance of machines and technical equipment as well as regular cleaning or disinfection of technical machine parts (e.g. the loading/unloading area, screens, tanks, filters) should be carried out.

Organic contamination can impair the effectiveness of disinfectants. For this reason, the reprocessing of cleaning textiles should guarantee that organic contamination is safely removed from these textiles (RKI recommendation "Anforderungen an die Hygiene bei der Reinigung und Desinfektion von Flächen" (Hygiene requirements for the cleaning and disinfection of surfaces) [11]). For the fulfilment of these requirements, it could make sense to test the cleaning effect of the reprocessing method and optimize it if necessary.

In the recommendation "Anforderungen an die Hygiene bei der Reinigung und Desinfektion von Flächen" (Hygiene requirements for the cleaning and disinfection of surfaces), RKI sets up requirements regarding the storage of reprocessed cleaning textiles. To prevent the multiplication of microorganisms, drying the textiles directly after washing, e.g. in a dryer, is the best solution. After reprocessing cleaning and disinfection utensils are to be stored so that they are protected against contamination by dirty utensils (separation into clean and non-clean areas) [11].

Without a drying step (direct use after reprocessing etc.) it is urgently recommended that tests for the hygienic state of the moist cleaning textiles be performed regularly, e.g. quarterly [13]. This also applies to the storage of cleaning textiles impregnated with disinfectant, which should not exceed 24 hours [13, 14]. Even cleaning textiles impregnated with an antimicrobial agent are prone to microbial contamination when being stored whilst moist. Adequate reprocessing is necessary also in this case.

DIN EN 14065 [2] describes a hygiene management system for laundries for the hygienic reprocessing of textiles. This system can also be used to structure the reprocessing of cleaning textiles under hygienic aspects. The hygiene management system according to DIN EN 14065 is based on good processing practice and additional preparatory measures. Good processing practice, for example, includes the assignment of responsibilities and the provision of adequate resources and personnel (see Appendix A of DIN EN 14065). Preparatory measures, for example, include the assignment of personnel responsible for hygiene, the obligations of management, and clear specifications in regard to relevant processes and materials. The hygiene management system according to DIN EN 14065 is based on 7 basic principles:

1. Risk analysis: Listing of microbiological risks and control measures
2. Determination of (critical) control points
3. Establishment of target values and tolerances for each (critical) control point
4. Establishment of a monitoring system for each (critical) control point
5. Establishment of corrective measures
6. Establishment of testing methods for the entire hygiene management system
7. Documentation

DIN EN 14065 thus describes tools to analyze the reprocessing under hygiene aspects and to design the requirements accordingly. It contains no microbiological limit values and can thus be adapted to various requirements and needs.

Appendix 3: Key parameters in various washing methods

The following exemplarily lists the differences with regard to the important parameters for the washing method for slightly and heavily soiled rags and for rags used in hygiene-relevant areas. The specification of sample washing methods is not meaningful here as the required parameters are achieved with various program sequences depending on the washing machine manufacturer and set wash program.

1. **Slightly soiled rags**
    - Brief pre-rinse
    - Main wash with sufficient water level (normally 60 °C as the washing temperature)
    - Good rinsing to remove all detergent residues
2. **Heavily soiled rags**
    - Thorough pre-rinse
    - Pre-wash at 40°C if necessary
    - Main wash with sufficient water level (minimum of 60 °C as the washing temperature)
    - Good rinsing to remove all detergent residues
3. **Hygiene-relevant washing method**
    - Pre-rinse depending on the degree of soiling and spin cycles (all relevant national and local regulations covering the discharge of effluent into the sewage system should be observed, e.g. municipal sewage regulations, leaflets DWA-M 115-1 [3], DWA-M 115-2 [4], and DWA-M 775 [5], and the regulations specified there).
    - Adapt the main wash according to the detergent and disinfectant used.
        - Suds level
        - Temperature holding time
        - Important: When using liquid detergent and disinfectant, make sure that the disinfectant is not added until the disinfection temperature is reached.
    - Good rinsing to remove all detergent residues

Appendix 4: Bibliography

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Quality management systems – Basic principles and terminology
DIN EN ISO 9001
Quality management systems – Requirements
DIN EN ISO 9004
Managing for the sustained success of an organization – A quality management approach
German versions all available through Beuth-Verlag, Berlin

[2] DIN EN 14065
Textiles – Laundry processed textiles – Biocontamination control system
Beuth-Verlag, Berlin

[3] Leaflet DWA-M 115-1
Indirekteinleitung nicht häuslichen Abwassers – Teil 1: Rechtsgrundlagen
(Indirect introduction of non-domestic waste water – Part 1: Legal Grounds),
DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V.
(German Association for Water Resources, Waste Water, and Waste), Hennef, 2013

[4] Leaflet DWA-M 115-2
Indirekteinleitung nicht häuslichen Abwassers – Teil 2: Anforderungen (Indirect introduction of non-domestic waste water – Part 2: Requirements),
DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (German Association for Water Resources, Waste Water, and Waste), Hennef, 2013

[5] Leaflet DWA-M 775
Abwasser aus Krankenhäusern und anderen medizinischen Einrichtungen (Waste water from hospitals and other medical facilities),
DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (German Association for Water Resources, Waste Water, and Waste), Hennef, 2010

[6] Biostoffverordnung (German Biomaterial Regulation) of 15 July 2013, BGBl. I p. 2514

[7] S 050 (TA 2048)
BG Information "Wäsche mit Infektionsgefährdung der Beschäftigten" (Laundry with risk of infecting workers), 2009

[8] Disinfectant list of VAH: List of the Disinfectant Commission in Verbund für Angewandte Hygiene (VAH) e.V. (Association for Applied Hygiene) for laundry disinfection.
Verbund für Angewandte Hygiene e.V., Bonn

[9] List of the Robert Koch Institute for tested and recognised disinfectant and disinfection methods
BGBL 2013/56: 1702-1705

[10] Communication from the Disinfection Commission of VAH: Desinfektionsmittel-Kommission - Fragen & Antworten: Gibt es Vorschriften zu Nachweisverfahren bezüglich der Keimbelastung von Waschmaschine / Waschgut? (Disinfection Commission – Questions & answers: Do regulations exist in regard to testing methods for the contamination of washing machines/laundry with germs?), HygMed 2011; 36 - 7/8 309-310

[11] RKI recommendation "Anforderung an die Hygiene bei der Reinigung und Desinfektion von Flächen" (Requirements for hygiene in the cleaning and disinfection of surfaces)
BGBl 2004/47: 51-61

[12] Test provisions of the wfk-Siegel für Textilhygiene (Seal for Textile Hygiene), Edition 2014-01

[13] Communication of the Disinfectant Commission of VAH: Fragen & Antworten: Standzeiten von Wischsystemen zur Reinigung und Desinfektion von Fußböden (Questions & answers: Soak times of wiping systems for the cleaning and disinfection of floors), HygMed 2012; 37 - 6, 257-258

[14] Arbeitskreis für Krankenhaus- und Praxishygiene der AWMF (Workgroup for Hospital and Practice Hygiene of AWMF). Hygienische Anforderungen an Hausreinigung und Flächendesinfektion (Hygiene requirements for house cleaning and surface disinfection). AWMF-Leitlinienregister (guideline register) No. 029/030. Hyg Med 2010; 35: 261-267.

Appendix 5: Additional literature

Weber, Ludwig C.
Reinigungsdienste und Hygiene in Krankenhäusern und Pflegeeinrichtungen
(Cleaning services and hygiene in hospitals and nursing homes)
Leitfaden für Hygieneverantwortliche (Guideline for people responsible for hygiene)
Springer Berlin Heidelberg, 2013

Appendix 6: FRT factsheets and leaflets

FRT guideline for "Mineralische Bodenbeläge“ (Mineral Floor Coverings), Edition: September 2012

FRT factsheet "Holzböden (Parkett) - Teil 1: Definitionen von Reinigungsarten und -verfahren" (Wood floors (parquet) - Part 1: Definitions of types and methods of cleaning), Edition: January 2011

FRT factsheet "Holzböden (Parkett) - Teil 2: Auswahl, Verlegung, Reinigung und Werterhalt“ (Wood floors (parquet) - Part 2: Selection, laying, cleaning, and value retention), Edition: January 2011

FRT factsheet "Elastische Bodenbeläge mit besonderen Anforderungen an das elektrostatische Verhalten in sensiblen Arbeitsbereichen - Definitionen, Normen, Einsatzgebiete, Fehlerquellen" (Elastische floor coverings with special requirements on electrostatic behaviour in sensitive work areas - Definitions, standards, areas of applications, sources of error), Edition: March 2006

FRT leaflet "Reinigungs- und Pflegeempfehlung rutschhemmende Fliesen" (Cleaning and care recommendations for anti-slip tiles), Edition: March 2003

FRT leaflet " for "Reinigung und Pflege von Holzböden - Hallen für Tanzsport" (Cleaning and care of wood floors - dance halls), Edition: April 2003

FRT leaflet "Reinigung und Pflege von Laminatböden - Laminatböden im Objektbereich und im Haushalt" (Cleaning and care of laminate flooring - Laminate flooring in buildings and households), Edition: April 2003

FRT leaflet "Reinigung und Pflege von Sporthallenböden - Hallen für Turnen, Spiele und Mehrzwecknutzung" (Cleaning and care of gymnasiums - Halls for gymnastics, games, and multipurpose use), Edition: April 2003

All FRT factsheets and leaflets named here are German language only and can be obtained from the FRT:

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Campus Fichtenhain 11
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