CINET
Professional Textile Care

Benchmark Study nr. 2014.4

SOLVETEX IV

Quality evaluation of practical wet cleaning systems

The goal of the Solvetex projects is to provide reference documentation for the textile cleaning industry. In Solvetex IV the cleaning performance of wet cleaning systems are evaluated under practical conditions. This means that the experiments are performed in operational dry cleaning shops, giving an indication of the overall performance of wet cleaning.

TKT

TKT is the Dutch technical knowledge centre for the textile care industry, for both the dry cleaning industry and the laundry industry. TKT initiates and coordinates technical and sustainable innovation projects for the Dutch and the International textile care industry. TKT is imbedded in international and networks and has extensive expertise about technological aspects of cleaning and washing such as (amongst others) sustainability of cleaning, alternative cleaning processes, energy saving, hygiene of cleaning and washing, life cycle assessments, environmental legislation for dry cleaners & laundries, textile functionalities and their relationship to washing processes. There are many ongoing projects about these aspects. Additionally, practical knowledge is transferred to the companies in the form of online educational material, both on a national and on an international level. TKT is closely affiliated to the Dutch national associations FTN (laundry) and NETEX (dry cleaning), as well as the umbrella association CINET (the international committee of professional textile care).

Introduction

In the previous Solvetex projects, TKT evaluated the performance of alternative solvents. Besides the developments of solvents, one of the major developments of recent years relates to wet cleaning systems. Due to changing legislation in different countries, the development of textile materials, the different needs of customers and new wet cleaning technologies, wet cleaning is more and more used. Wet cleaning systems are based on water as solvent in combination with suitable chemicals, reduced mechanical action, specialized equipment and specific programs. Wet cleaning is defined as mild professional aqueous cleaning of delicate and non-washable textiles, which is to be distinguished from washing or laundry. Currently professional textile cleaners have an extensive choice of cleaning and drying equipment, chemicals, programs and finishing equipment. Therefore the systems evaluated in this report are only used as examples for demonstrating the ability of wet cleaning technology to the professional textile cleaning industry in general. The specific results of the different wet cleaning systems depend on the equipment used, the programming, process parameters and chemicals as well as drying conditions, skills and knowledge of the operator. And last but not least, the type of stains and sensitivity of the textiles processed.

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Conclusion

There is a wide range of wet cleaning systems available, all having their own specifications. After the quality evaluation of practical wet cleaning systems in this study it can be concluded that:

- The overall cleaning performance of wet cleaning is good.
- A specific advantage of wet cleaning systems compared to solvent based systems is the ability to remove water soluble stains.
- The differences in specific stain removal of wet cleaning systems depend on the equipment, process settings and chemicals used as well as drying conditions and have to be considered in relation to product specifications.
- The greying of cotton and wool items is acceptable for all wet cleaning systems.
- The deformation of wool and cotton is acceptable for all wet cleaning systems.
- Finishing is an important step in professional textile cleaning to deliver high quality garments.

Materials

The cleaning performance was studied under real life conditions, by means of a number of test items and test swatches, to determine the effect on appearance like shrinking, greying and stain removal. The test methods in all the Solvetex projects were the same and can be used as reference for the cleaning technology. Three model test swatches of each type were cleaned every cycle and each cleaning cycle was carried out three times to obtain representative results. The load existed of the textile package, the test swatches and additional standardized textiles to meet the required (optimal) load.

Textile package existing of:

- A new jacket for each system, P labelled (83% polyester, 15% viscose, 2% elastane and 100% polyester lining)
- A new jacket for each system, P labelled (100% wool, 100% viscose lining)
- The textile materials were measured to evaluate the look, shrinkage and finishing results.

Test materials for the assessment:

- Test swatches with standard stains for spot removal (MSM)
- Test swatches of cotton (ISM-C1) and wool (ISM-W1) for shrinkage, greying and roughening

The test materials were measured to determine the cleaning performance, shrinkage and greying.

Equipment and processes

The equipment, processes and chemicals were used as available in the operational textile cleaning shops. The detergents were used as supplied and the process conditions for each system were chosen after consulting the suppliers.

- System 1: Equipment: Girbau, Chemicals: Seitz, 17 kg wet clean machine, process at 25°C, dosing of detergent and conditioner, tumble drying at 75 °C, no residual humidity sensor used, drying result controlled by the operator, unloaded from the dryer with residual humidity.
- System 2: Equipment: Miele, Chemicals: Kreussler, 16 kg wet clean machine, process at 30°C, dosing of detergent and conditioner, tumble drying at 60°C, no residual humidity sensor used, drying result controlled by the operator, unloaded from the dryer with residual humidity.
- System 3: Equipment: Electrolux, Chemicals: Concord Textile, 24 kg wet clean machine, process at 25°C, dosing of detergent and conditioner, tumble drying at 40-45°C, residual humidity sensor used, drying result controlled by the operator, unloaded from the dryer with no residual humidity (dry on touch).
- System 4: Equipment Girbau, Chemicals: Büfa, 17 kg wet clean machine, process at 25°C, dosing of detergent, pH regulator and conditioner, no tumble drying used at all (garments were dried during finishing).

The cycle time of the cleaning programs was approximately 20 minutes for all wet cleaning systems. The drying process was not exactly timed. In practice all but one did not use a moisture control system for the drying procedure (not available or not used) and the end of the drying process was determined by hand of the operator. One system used moisture control (set at 0% residual humidity) plus extra drying time until no residual humidity was detected (dry on touch). The results of the study are certainly influenced by the differences between the systems such as the equipment used, the programming, the level of extraction, the temperature, the characteristics of the chemical products used the drying conditions and the drying times as well as the finishing (equipment). Therefore the results are only intended to give an indication of the overall performance of wet cleaning.

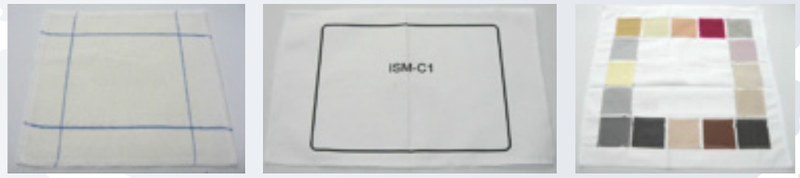

Figure 1: test swatches ism-wool, ism-cotton, Multi Soil Monitoring

Evaluation Cleaning performance

In order to measure the cleaning performances, the complete cleaning systems have been tested. Including the equipment, washer and dryer, the detergents and conditioners and the settings or programs as used in practice. What was excluded from the test are the pre and post spotting or any other special treatments.

The evaluation is based on the following criteria:

- Stain removal (of the model soil on the multi soil monitoring swatches)
- Greying of cotton and wool (on the test swatches)
- Deformation or shrinkage (of the textile package and test swatches)

Cleaning performance

The cleaning performance has been determined by measuring the stain removal performance of standard stains. The stains have been subdivided into water soluble and non-water soluble stains. The current measurements of the wet cleaning systems are compared to the results of Perc and HCS from previous Solvetex projects, to create an overview of the general available cleaning systems and their performance. The results are presented per type of stain in figures 2 and 4 and visually as the total relative average cleaning performance of wet cleaning in figures 3 and 5.

Non water soluble stain removal

The overall cleaning performance of non-water soluble stains does not differ significantly from the tested wet cleaning systems, although specific stain removal results can be different. As expected the wet cleaning systems have a lower cleaning performance on fat, grease and oil based stains than the solvent based systems due to the limited interaction between water and these types of stains. The use of detergent enhances the removal of non-water soluble stains.

Stain removal % Non water soluble	PERC	HCS	System 1	System 2	System 3	System 4
Sebum (wool)	99	93	80	65	55	32
Cacao/Lanolin	67	55	20	23	25	20
Olive oil/carbon	5	3	2	2	2	2
Mineral oil/carbon	8	4	2	0	1	1
Sebum (pe/cotton)	49	31	22	24	12	14
Sebum	45	37	19	16	15	12
Egg yolk	65	57	14	17	46	22
Grass	0	0	0	0	0	0
Make-up	9	0	0	0	0	0
Lipstick	57	27	4	4	4	3

Figure 2: the cleaning performances shown per non-water soluble stain, the stain removal in % per cleaning system

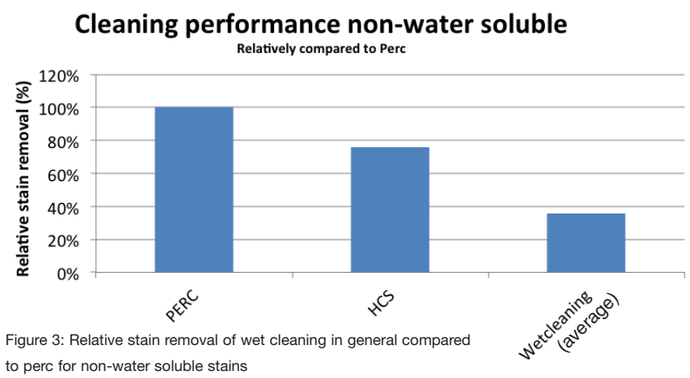

Figure 3: Relative stain removal of wet cleaning in general compared to perc for non-water soluble stains

Water soluble stain removal

The stain removal of water soluble stains in wet cleaning is significantly higher than in solvent based systems, which is expected due to the good interaction of the soil with water. This can be beneficial for the removal of stains like sweat and odour. The cleaning performances of the wet cleaning systems on specific stains like bleachable tannin stains (coffee and tea) or protein stains (blood/milk/ink) shows some differences. The difference with regards to specific stain removal capabilities might be caused by differences in the process, like temperature and mechanics or specifics of the detergent formulations.

Stain removal % Water soluble	PERC	HCS	System 1	System 2	System 3	System 4
Red Wine	0	0	24	22	31	37
Coffee	0	0	1	0	1	11
Tea	0	1	3	3	4	15
Blood/Milk/Ink	1	1	3	4	12	0
Blood	1	1	1	1	12	14
Spinach (wool)	23	16	99	95	100	100

Figure 4: the cleaning performances shown per water soluble stain, the stain removal in % per cleaning system

The overall cleaning performance of wet cleaning is good. The difference in specific stain removal has to be seen in comparison with the process, settings, chemical formulation and product specification. This was not a part of this evaluation. An advantage of wet cleaning systems is the ability to remove water soluble stains like odours and sweat more easily.

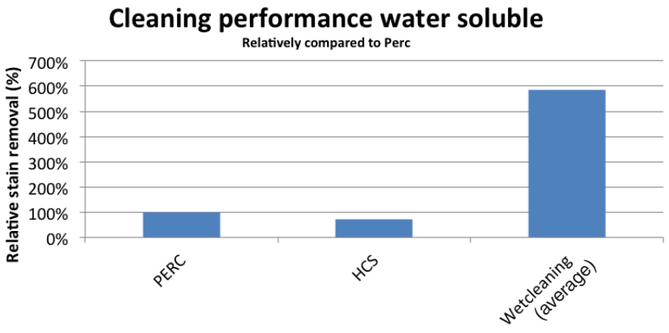

Figure 5: stain removal of wet cleaning in general compared to perc water soluble stains

Greying

The greying is measured by the reflection of the light using a Tristimulus Reflection Colorimeter using a green filter. The results were measured after the test swatches were cleaned and dried three times. The results are as expected, keeping in mind the dark load and the white test swatches. No significant differences between the results were noticed for the wool and the cotton swatches. The greying of cotton and wool items was acceptable for all wet cleaning systems. Compared to the greying of the solvents, Perc and HCS the results are in general comparable.

Easy of finishing

An important aspect of professional textile cleaning is the finishing procedure to re-shape the garment and to be able to deliver high quality to the customer. The result and ease of the finishing process determines largely the performance and quality of the process. In the TKT project “market oriented finishing” it was determined that personnel cost of finishing is the largest contributor to the cost price of the garment. The ease of finishing and the quality after the process is therefore very important.

Evaluation finishing

To be able to have an indication on the ease of finishing all test garments have been finished on a form finisher, without additional ironing or treatment. The garments were finished after each cleaning and drying procedure. Because the processes of drying as well as the finishing equipment were different in all shops no direct comparison between the wet cleaning systems was made. However, after the standard finishing (on the form finisher) the jackets were finished by ironing and pressing after completion of the on-site tests. This in order to achieve a high quality by the same experienced dry cleaner and using the same equipment to be able to identify the required time and effort. The deformation of the textile package was measured after the standard finishing process and the deformation of the test swatches after the cleaning and drying cycle and after a finishing step using an ironing board by blowing steam.

Finishing results

The result of finishing for the synthetic jacket is good for all wet cleaning systems, although some differences in wrinkling were noticed between the different systems. Wrinkling may require extra attention when finishing but can be removed with relative ease. The synthetic jacket also showed good dimensional stability of the outer layer, the interlining fabric or canvas and the lining when cleaned, dried and finished in a wet cleaning system.

The results of the woollen jacket after finishing showed more deviation between the evaluated wet cleaning systems. Especially the fused interlining fabric caused wrinkling and bubbles to a certain extent, depending on the system used. Ironing attention was needed to reduce this effect. Also the connection of the arms to the body was subject to wrinkling and deformation. The overall result for this jacket is that wrinkling and bubbles were noticed in all cases, although at varying degrees. It depended on the mechanical action of cleaning and drying, the drying procedure, chemical interaction and the finishing step. To a large extend these effects, in practice, can also be influenced by the quality of the garments.

Figures 6 and 7: Examples of the different results after finishing on a form finisher, prior to ironing. After 3 cleaning and drying cycles. Strong appearance of bubbles and wrinkles on the left; very limited appearance of bubbles and wrinkles on the right (all removed after ironing)

Finishing Time

Textile cleaning must be considered as a total process including cleaning, drying and finishing. After unloading the tumble dryer, delicate garments are typically hanged prior to finishing. After the finishing on a form finisher (for 1 to 3 minutes, depending on the system and equipment) extra attention for finishing is required to be able to deliver high quality finished garments (in one of the systems drying was performed by using the blower of the form finisher). The determination of the additional required finishing time was performed by the same skilled operator, using the same equipment, performing the finishing for all the test materials. The finishing sequence applied started with the finishing on a form finisher, followed by pressing and additionally ironing by hand. The extra finishing of the synthetic jacket required about 3 minutes to achieve a high quality result and for the woollen jacket 4 to 5 minutes depending on the system used. For all wet cleaning systems finishing was considered an important step to deliver high quality garments.

Deformation and shrinkage

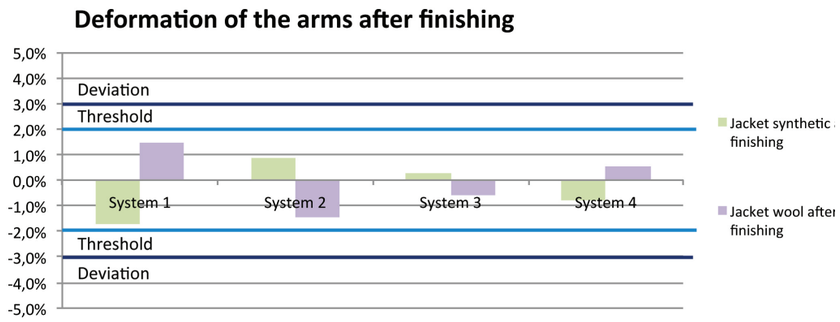

Figure 8: the deformation of the jacket arms measured after finishing (negative is shrinkage, positive is deformation)

The textiles cleaned in the wet cleaning systems are sensitive to water and can be sensitive to deformation or shrinkage. The test jackets are measured before the test, after the drying steps and after the finishing steps on the form finisher, as present at the test locations. The lengths of the arms are measured (figure 8) and the length and width of the back are measured (figure 9) to determine deformation after the finishing step. The deformation or shrinkage of the arms of the woollen and synthetic jacket after the standard form finishing process is within a threshold value of 2% for a new jacket. This means that the deformation of garment for all wet cleaning systems is acceptable. The threshold value represents an acceptable deformation. The deformation results depend on the skills of the employees, the cleaning and drying processes and the finishing equipment used. The finishing process can have an important influence on the result. The deviation value represents the accuracy of the measurement. It has been established that deviations of +/- 1% can influence the specific results.

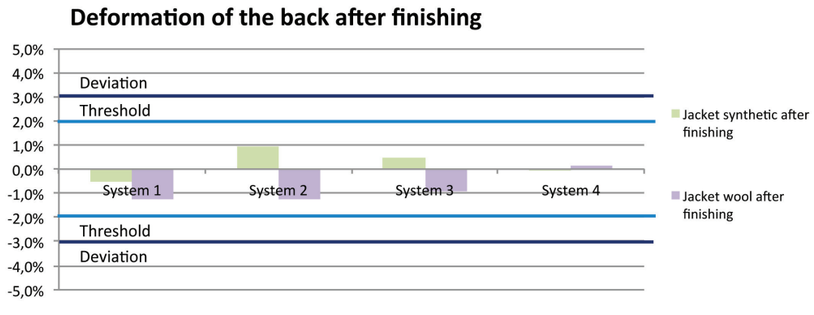

Figure 9: the deformation of the jackets back measured after finishing (negative is shrinkage, positive is deformation)

The deformation or shrinkage of the back of the woollen and synthetic jackets is within an acceptable threshold value of 2% for a new jacket for all wet cleaning systems. It was taken into consideration that the finishing process is an important step in the practical wet cleaning process. It has been established that deviations of +/- 1% can occur due to variations in the accuracy of the measurement, influencing the results. The level of deformation after finishing, largely depends on the skills of the operator, the cleaning and drying processes and the finishing equipment used.

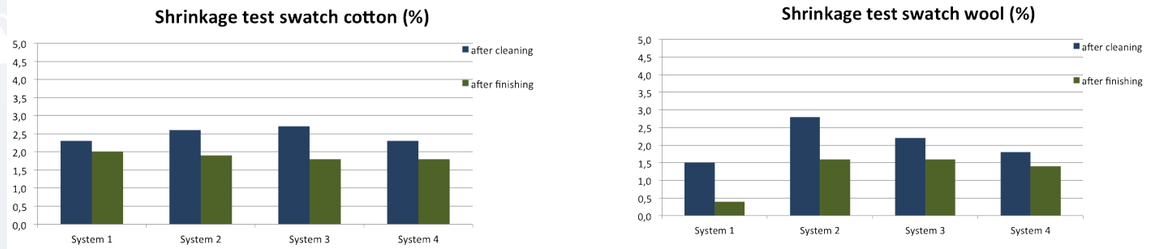

Figure 10 and 11: the shrinkage of the test fabrics after cleaning/drying and after finishing (by blowing steam on a hot ironing table)

The level of shrinkage is also measured by the delicate test swatches of wool and cotton. Test swatches are more sensitive than the textiles on the market. The finishing of the test swatches on an ironing board by blowing steam reduced the shrinkage in all cases to an acceptable level of deformation for the test swatches. All wet cleaning systems show an acceptable shrinkage of cotton items. It was considered that the finishing process is an important step in the practical wet cleaning process to reduce deformation.

The shrinkage levels of the wool test swatches show more deviations between the different systems. This can be due to the different processing settings like the cleaning and drying procedures. The deviation line shows the differences that can occur when measuring the same item several times. This can influence the results significantly. The shrinkage of wool is reduced significantly after finishing on an ironing board by blowing steam; this is considered an important step in the wet cleaning process. After finishing all wet cleaning systems result in acceptable shrinkage of the wool swatches. Slight roughening of the woollen test swatches is noticed after the wet cleaning cycles, probably due to the drying procedures. When no tumble drying process is used no significant roughening is noticed. The level of shrinkage should be set against specific process parameters like drying and mechanical action, which varies between the systems.

General remarks

The results of the experiments are valid for the test materials and textiles used. Other textile materials or qualities can result in different behaviour and results. Wet cleaning becomes more important worldwide. It can be used as complementary system to solvent based systems or used as stand-alone system. In all the shops where the experiments were performed, extensive experience, skills and knowledge of textile materials, stains and processes were available. The experiments were performed in cooperation with the suppliers of the chemicals. One of the greatest benefits of wet cleaning, as seen by customers, is the freshness of the garments that have been wet cleaned.

CINET
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P.O. Box 10, NL-4060 GA Ophemert

Tel.: +31 344 65 04 30 Fax: +31 344 65 26 65

e-mail: info@cinet-online.com www.cinet-online.com

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