

# **Interference between hygiene properties and energy saving for low energy European laundering processes.**

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## **Abstract**

In the seventies the magnitude of societies energy consumption did become an international concern. The main target became to achieve a sustainable level of energy consumption. As a result the average temperatures and the water levels in European washing machines have decreased considerably. In addition other process parameters have changed. This implies that the conditions for appropriate laundry hygiene have been stressed. In this research the hygienic effects of the present textile laundering habits are investigated. For four countries the hygienic quality of washed domestic laundry is evaluated. The results reveal that the hygienic effect of low temperatures cleaning has to be taken into account for future energy measures.

## **Introduction**

In the seventies the magnitude of societies energy consumption did become an international concern. The main target became to achieve a sustainable level of energy consumption. This implies that no more energy is used than the eco-system can supply. The initial reduction measures in the seventies and eighties were relatively easy and very successful. But when more saving technologies were introduced the additional savings became less. As a result of the energy saving measures the average washing temperatures in Europe has decreased considerably over the last decades. In addition the process time and water levels have changed. As a total result it may be concluded that the conditions for appropriate laundry hygiene haven been stressed. Little is known about the hygienic effects of these changes in daily practice. In this research the hygienic effects of the present way of textile laundering are investigated. Four European countries are selected because of their characteristic washing habits. For each country the hygienic quality of washed naturally soiled domestic laundry is assessed.

In this paper the impact of past energy saving measures on laundry hygiene are elaborated. In addition some strategies for appropriate hygiene in combination with energy efficient technology will be discussed.

## **Development of laundering technology**

After the club of Rome in 1972 pointed to society's impact on natural resources and energy, technology and consumption as well as domestic technology and practices have changed substantially. Currently, domestic appliances use less energy and water. Household chemicals, like cleaning agents, produce less harmful emissions. Although consumer practices have become more sustainable, according to present insights, the current situation still is not sustainable and further measures are needed. This applies also to domestic laundering in Europe. National and European legislation, like the ban on phosphate and non-biodegradable surfactants, have guided the industry in this sustainable direction. Consumer practices have been influenced by information from various sources. In the current situation, European consumers wash at lower temperatures with biodegradable detergents [2]. Several institutions have monitored the cleaning properties of these changed laundering practices. But until today, little attention has been spent on the hygienic properties of sustainable laundering practices [3]. During usage, textile articles are contaminated with visible soil and invisible microorganisms. These microorganisms may, under certain conditions, pose a health risk. By textile laundering, the number of microorganisms can be substantially reduced [4] [5] [6].

Several laboratory scale studies have shown that lower a wash temperature and a reduction of the bleach activity reduce the overall level of hygiene of the washed laundry [7] [5].

Since textile hygiene is a major benefit of laundering and past changes in washing practice may have stressed the conditions for appropriate hygiene, more insight into the hygienic implication of modern wash practices in real life situations is needed. The research in this paper aims to assess the hygienic implications of sustainable laundering practices in European. And thus creating a basis for future policy measures in this domain. The focus of the study is on the impact of temperature lowering and water saving.

### *Laundering Hygiene research*

The objective is to assess the hygienic effect of entire washing processes as are normally used in the different regions in Europe. For that purpose first a set of representative regions/countries are chosen. Then a consumer survey to find out the washing practices in these regions is run. And finally the hygiene effect is assessed by measuring the contamination level of the laundry before and after a washing process.

Block et al. [8] recently published a test method to determine the antimicrobial effect of laundry detergents within a washing process. In this test, artificially contaminated micro-organism carriers are washed together with sterile ballast fabrics in a normal washing machine under realistic conditions. After a complete washing cycle the surviving test organisms on the carriers are determined.

The objective of the present research is to assess the hygienic effect of a complete washing process in real life conditions. Therefore in this study the reduction and cross-contamination are assessed on naturally soiled domestic laundry.

In Europe there is a distinct difference between the northern and southern countries. It was chosen to include one country from north Europe, two from the south and one from middle Europe. These countries are Norway, the Netherlands, Spain and Greece. In each of the four countries an enquiry among approximately one thousand households was held to find out the washing practices. The enquire supplied information about; the washing programs most used, type and brand of detergents, detergent dosage per cycle, degree of machine loading and the average water hardness to be used.

The microorganisms in the study are selected on the basis of a literature study. The germs selected are: *Enterobacteriaceae*, *Bacillus*, *Staphylococcus aureus* and *Yeasts and fungi*. All microorganisms selected are known to be found on laundry and pathogenic or members of a group with pathogens. In addition it was decided to assess the overall hygiene level of the textile articles by means of a total plate count.

Laundry items that have been used in normal practice have been chosen on the bases of expectations with respect to the presence of the microorganisms. The occurrence and amount of micro-organisms on the laundry items hereafter has been determined in a pre-test.

- Handkerchiefs; because a large part of the human population is carrier of *Staphylococcus aureus* in the nose,
- *Diapers*; as many bacteria occur in faeces; *Enterobacteriaceae*, *Bacillus* and *Staphylococcus aureus*,
- *Socks*; foot moulds, yeasts and fungi are likely to be found in socks,
- Dishcloth, studies [9] [10] reveal that a dishcloth is a highly contaminated piece of laundry.

To obtain the same level of initial contamination in the different wash tests the samples were cut into pieces and mixed. Sterile cotton test cloth is used for the assessment of cross contamination in the washing process. After the wash treatment the contamination of the the washed samples was assessed.

### **Execution of the wash tests**

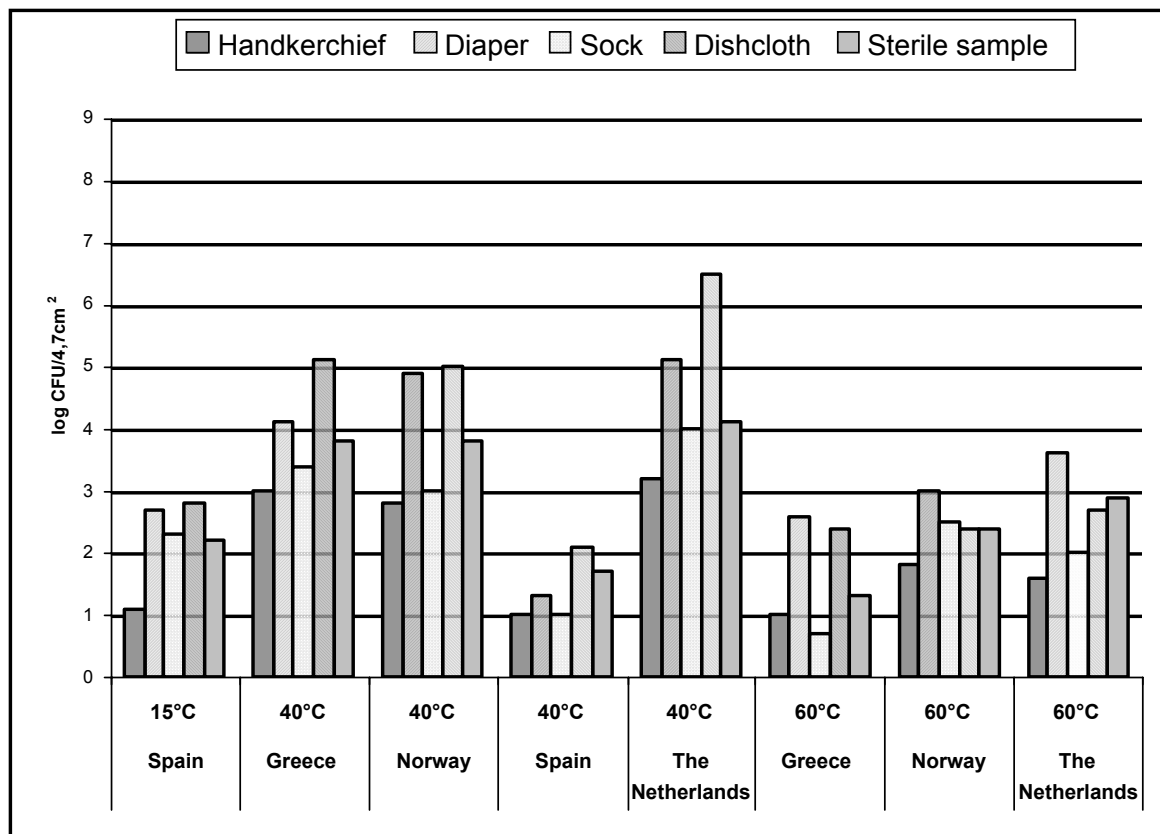
All wash tests are run in a clothes washing machine for household use; a horizontal axis drum washing machine. Before each wash test the machines are cleaned and disinfected. Then the machines are loaded with a base load and test materials, detergent and the process was started. After the wash cycle the test materials are collected and the contamination is assessed. The relation

between the contamination before and after washing gives information about the hygiene properties of the process. The contamination after washing of the sterile samples shows the degree of cross contamination.

Each of the selected washing processes is run once. In order to obtain an acceptable soil load 12.5 ml defibrinated sheep blood per kilogram base load is added. The composition of the cotton base load is in accordance with IEC 60456 [11]. To avoid cross contamination from the base load, the load is sterilised with gamma-radiation before each test cycle. A sample of the unwashed test material was taken for determining of the initial contamination. The sterile samples are autoclaved. The washing machine was treated with a 95°C programme using bleach containing detergent.

## Results

The germ reduction properties of the most common washing processes in Greece, Norway and the Netherlands are more or less comparable (figure 1). For the 40°C processes the total plate count reduction amounts  $\pm 0.5$ , 3 to 5,  $\pm 2$  and 2 to 3 log units for handkerchiefs, diapers, socks and dish cloth. The germ reduction of a 60°C wash programme is 1 to 2 log units better than the 40°C programme. The hygienic quality of laundry washed with the washing processes is in line with the expectations. The results from the Spanish washing processes seem to be very out of line. The difference between the Dutch and the Spanish washing processes was confirmed by statistics (ANOVA-One Way,  $\alpha < 0.05$ ).



**Figure 1: Germs on washed textiles; total plate count**

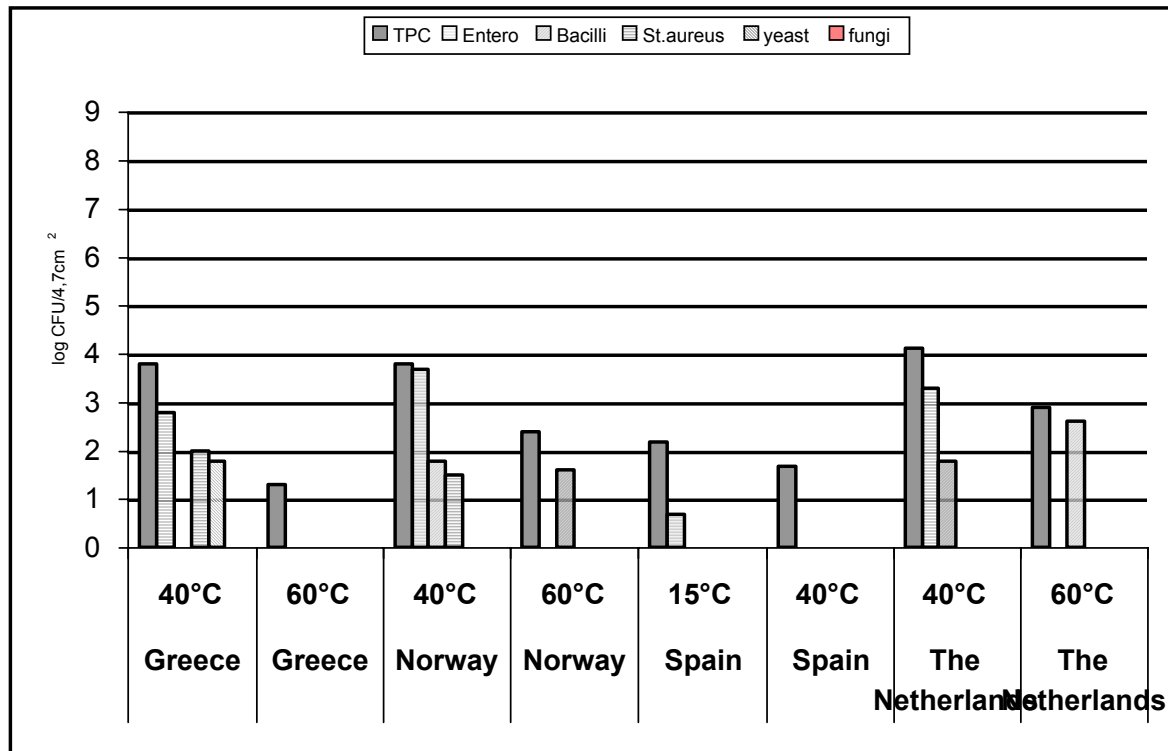
A higher temperature had a positive effect on the hygiene properties; this was found for the difference between the 15°C and 40°C programs and between the 40°C and 60°C programs (ANOVA-One Way,  $\alpha < 0.05$ ). In general, the hygienic quality is better when the washing temperature is rising.

Because no explanation was found for the good hygiene properties of the Spanish processes, a further analysis was performed. In additional tests it was found that because of the foaming properties of the detergent the washing machine added additional rinses. These rinses appear to supply the additional hygiene effect. In an additional experiment this effect of an extra rinse was confirmed.

A positive effect of bleach on the hygienic quality of laundry is found (ANOVA-One Way,  $\alpha < 0.05$ ). This is also confirmed by a additional tests.

Statistical analysis shows that there is a synergic interaction between temperature and bleach effect. When a detergent contains bleach and the washing temperature rises, the hygienic quality is better than the two separate effects.

After the wash process the sterile samples were contaminated. The degree of contamination was comparable with the other test samples. This implies that germs are redistributed during the washing process. This cross-contamination is shown for the different germs for each process in figure 2. In general, the cross-contamination of the sterile samples in the 60°C programs tends to be lower than in the 40°C program. The situation in Spain is completely different from the other countries.



**Figure 2** Cross-contamination in the most common washing processes in Europe

When the contamination level of the Spanish 15°C program is compared to the 40°C programs of the other countries an interesting result appears. The cross contamination level in Spain is relatively low. Additional tests show that the extra rinses in the Spanish programs that deliver the better hygienic level are responsible for the better cross contamination also.

### Conclusions and discussion

In this research the hygienic effects of different washing processes in four European countries are assessed. The two most common washing processes in each country are studied. For that purpose, the microbiological count of relevant micro-organisms on naturally soiled domestic laundry is determined before and after washing. The naturally soiled laundry is applied to make sure that the results are valid for the consumer practice. Earlier research shows that results from artificially inoculated test samples are not representative for the normal practice.

The hygienic quality of the most common washing processes in Greece, Norway and the Netherlands is more or less comparable. The results show that the hygienic quality of the washing processes at 40°C is substantial lower then at 60°C. For some types of laundry the total contamination (Total Plate Count) is hardly reduced by the 40°C cleaning process.

The 60°C programs perform better but even with these programs the laundry remains contaminated after the wash process. This means that a washing process at 60°C or lower does not reduce the presence of germs to the amount as is seen for the traditional boil wash programs (4).

The research confirms that increased washing temperatures and the presence of bleach agents in the detergent improve the level of hygiene. This is confirmed by additional research. In this scope temperature and bleach do show a synergic effect.

Furthermore it is shown that the hygienic effect of laundering differs between different textile types.

The results obtained with the Spanish washing processes appear to differ substantially from results for the other European countries. The germ reduction of these processes is substantially higher. One explanation for this is the extra rinse, which is added to the wash cycle due to extensive foaming.

Sterile samples were contaminated after washing with all the types of bacteria that were included in the research. This shows that modern washing redistributes the micro-organism among the washed items.

Another interesting outcome of this research is the increased hygienic quality of the laundry items after adding an extra rinse to the washing process. This finding came up when verifying the Spanish results. The Spanish hygiene level was found to be higher than in the other European countries.

Summarising it may be concluded that measures to reduce the energy consumption of the textile cleaning have stressed the conditions for appropriate hygiene. As the effort to attain sustainability continues, further environmental measures will be needed. Further lowering of the wash temperature and the water consumption may be considered. If no solutions are created, the previous measures are likely to endanger the level of hygiene in private households.

Scientists dealing with hygiene or processes that may affect the hygiene should be aware of these phenomena. They should search for ways to solve the problems, before they can affect the quality of public health. In the future these specialists will be faced with the challenge of creating household and industrial processes that are fit for use, sustainable and that do not affect the level of hygiene.

## References

1. Terpstra, P.M.J., Assessment of cleaning efficiency of domestic washing machines with artificial soiled test cloth, Institut für Landtechnik der Rheinisch Friedrich-Wilhelms-Universität Bonn. 2000, Rheinische Friedrich-Wilhelms-Universität Bonn: Bonn. p. 119.
2. Revision of energy labelling & targets washing machine (clothes). 2001, NOVEM: the Netherlands. p. 76.
3. Terpstra, M.J., The correlation between sustainable development and home hygiene. American Journal of Infection control, 2001. 29(4): p. 211- 217.
4. Terpstra, P.M.J. Hygiene and disinfection in every day life. New insights in domestic hygiene & infection in the home. 2000. Institute Pasteur, Paris: Institute Pasteur.
5. Walter, W.G. and J.E. Schillinger, Bacterial survival in laundered fabrics. Journal of applied microbiology, 21975. 29: p. 368-373.
6. Scott, E. and S.F. Bloomfield, Investigations of the effectiveness of detergent washing, drying and chemical disinfection on contamination of cleaning cloths. Journal of Applied Bacteriology, 1999. 68(3): p. 279-283.
7. Betz, M. and G. Cerny, Antimicrobial effects of bleaching agents. Tenside Surf. Det., 2001. 38: p. 242-249.
8. Block, C., et al., Determination of the microbicidal effect of laundry detergents. Tenside Surf. Det., 2001. 38(3): p. 130-146.

9. Finch, J.E., J. Prince, and M. Hawksworth, A bacteriological survey of the domestic environment. *Journal of Applied Bacteriology*, 1978. 45: p. 357-364.
10. Speirs, J.P., A. Anderton, and J.G. Anderson, A study of the microbial content of the domestic kitchen. *International Journal of Environmental Health Research*, 1995. 5: p. 109-122.
11. SC59D, I., Clothes washing machines for household use - Methods for measuring the performance. 1998, International Electrotechnical Commission: Geneva.