Scanning and Evaluation of crease resistant resins

Julia Kalholm & Johanna Strömbom

- For IKEA of Sweden
# Scanning and evaluation of crease resistant resins – For IKEA of Sweden

Julia Kalholm, julia.kalholm@hotmail.com

Johanna Strömbom, johannastrombom@hotmail.com

## Bachelor degree
**Final Thesis (15 HP)**

<table>
<thead>
<tr>
<th>Subject:</th>
<th>Textile technology, crease resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institution:</td>
<td>Swedish School of Textiles</td>
</tr>
<tr>
<td>Examiner:</td>
<td>Nils-Krister Persson</td>
</tr>
</tbody>
</table>
| Mentor, school: | Veronica Malm  
Swedish School of Textiles |
| Mentor, company: | Anna Palmberg  
+46 (0) 476 586812  
Marius Lehadus  
+46 (0) 476 81281  
IKEA of Sweden AB  
Tulpanvägen  
Box 702  
343 81 Älmhult  
Sweden |
Preface

This report is written by two students at the Swedish School of Textiles as a last project in the bachelor degree of textile technology. The work concerns 15 Swedish university points. The presented project is a task handed out from the company IKEA, concerning the crease resistant finishing of their bed linen. This final project and report is meant to provide IKEA with a global scan of potential suppliers of resins for this particular finishing. The work has been conducted at The Swedish School of Textiles and the School of Engineering in Borås.

A special thanks is given to our mentor at The Swedish School of Textiles, Veronica Malm, and to our mentors at the company IKEA, Anna Palmberg and Marius Lehadus.

Borås, May 2011
Julia Kalholm and Johanna Strömbom
Abstract

In today’s society, textile producers and manufacturers strive to use as little harmful chemicals as possible in their finishing of textiles. Though, producing a completely chemical free fabric is nearly impossible, many companies work actively to scan and evaluate alternatives to chemical substances that have a negative effect on the environment and the human health.

Prior preparations for the practical part of this project were conducted in a literature study, which entailed studying articles based on similar projects. Practical information was attained from the mentors at IKEA and from contact with the suppliers of the tested resins.

A study of alternative methods of testing the resistance to creasing of textiles was conducted to the benefit of IKEA. A practical evaluation of the smoothness appearance of the test specimens resulted in a development of this existing method.

To reassure the quality of the scan, obtained resins were treated on cellulosic weaves, and later on evaluated based on demands IKEA has for easy care treated textiles. The demands concerning the content of formaldehyde and the grade of smoothness appearance retained after ten washes where followed throughout the whole project. The evaluation was conducted based on several quality tests made on the treated weave. This resulted in a recommendation of four different resins for IKEA to further investigate.

Key words: Crease resistant finish, Easy care resin, DMDHEU resin, Formaldehyde free resin, IKEA, bed linen, Formaldehyde
1. INTRODUCTION .......................................................................................................................... 7
   1.1 BACKGROUND .......................................................................................................................... 7
   1.2 DESCRIPTION OF THE COMPANY ....................................................................................... 7
      1.2.1 History and facts .............................................................................................................. 7
      1.2.2 Textile products and production .................................................................................. 8
   1.3 PURPOSE .................................................................................................................................. 8
   1.4 PROBLEM AND QUESTIONS AT ISSUE .................................................................................. 8
   1.5 SUBJECT LIMITATIONS ......................................................................................................... 8

2. METHOD ......................................................................................................................................... 10
   2.1 LITERATURE STUDIES ........................................................................................................... 10
   2.2 PRACTICAL INFORMATION STUDIES .................................................................................... 10
   2.3 EXPERIMENTAL DESIGN ....................................................................................................... 10
      2.3.1 Test methods - ISO standard .......................................................................................... 11
   2.4 MATERIALS .............................................................................................................................. 12
   2.5 CHEMICALS ............................................................................................................................. 13

3. THEORY ......................................................................................................................................... 14
   3.1 CHEMICAL FINISHING (CONTINUOUS PROCESS) ............................................................... 14
   3.2 EASY CARE CHEMICALS ......................................................................................................... 15
      3.2.1 History .................................................................................................................................. 15
      3.2.2 Easy Care chemicals required properties ....................................................................... 15
      3.2.3 Different forms of easy care chemical resins ................................................................. 15
      3.2.4 Easy care chemicals for bed linen (finishing process) .................................................. 16
   3.3 FORMALDEHYDE .................................................................................................................... 16
   3.4 SUPPLIERS AND THEIR CHEMICALS .................................................................................... 17
   3.5 TEXTILE MATERIALS AND CHEMICALS ............................................................................. 18
      3.5.1 Cotton ............................................................................................................................... 18
      3.5.2 Lyocell ............................................................................................................................... 19
      3.5.3 Chemical ........................................................................................................................... 19
   3.6 ALTERNATIVE EVALUATIONS OF SMOOTHNESS APPEARANCE ..................................... 20

4. EXPERIMENTAL WORK ................................................................................................................ 21
   4.1 EASY CARE CHEMICALS EVALUATED .................................................................................. 21
   4.2 LABORATORY WORK .............................................................................................................. 21

5. RESULT .......................................................................................................................................... 25
   5.1 SMOOTHNESS APPEARANCE AFTER WASHING (MONSANTO, SS-EN ISO 6330) ............... 25
   5.2 DIMENSIONAL CHANGE AFTER WASHING (SS-EN ISO 3759) ........................................... 27
   5.3 TENSILE STRENGTH (ISO 13934-1) ....................................................................................... 28
   5.4 FORMALDEHYDE CONTENT (ISO 14184-1) ......................................................................... 29
   5.5 DEVIATION FROM INDICATED WEIGHT (ISO 3801) ............................................................. 31
   5.6 DEVELOPMENT OF THE EVALUATION OF SMOOTHNESS APPEARANCE AFTER WASHING .................................................................................................................. 32

6. DISCUSSION ................................................................................................................................... 33
   6.1 METHOD DISCUSSION ............................................................................................................ 33
   6.2 RESULT ANALYSIS .................................................................................................................. 34

7. CONCLUSION AND RECOMMENDATIONS ............................................................................... 37

8. SUGGESTIONS FOR FURTHER STUDIES .................................................................................... 38

9. REFERENCES ................................................................................................................................... 39

10. APPENDICES ............................................................................................................................. 43
    APPENDIX 1 – COMPANY FACTS ............................................................................................... 43
    APPENDIX 2 – 11 – TECHNICAL DESCRIPTIONS ...................................................................... 45
1. Introduction

This is a final thesis concerning 15 Swedish university points, made as a last project in the bachelor degree of textile technology at the Swedish school of Textiles in Borås. The project this report will present is a task handed out from IKEA concerning the finishing of their bed linen with crease resistant features. This final project and report are meant to provide IKEA with a global scan of potential suppliers of resins for this particular finishing. These suppliers and resins are chosen and evaluated based on different demands IKEA has for this treatment and for the finished product it concerns.

In this first chapter named Introduction, the background, the purpose and the limitations of the report will be presented. It will also provide the reader with information about the company IKEA.

1.1 Background

IKEA strive to use as little chemicals as possible in their products. Their most popular bed sheet, a woven sateen in 100 % cotton, is not prepared with any chemicals other than those necessary in standard finishing of cotton weaves, such as chemicals used in singeing and mercerizing, etc. However, IKEA have received complaints from customers that this particular bed sheet has the negative property to crease after washing. IKEA therefore has a vision to implement crease resistant finishing. This vision concerns the popular cotton bed linen, but also other bed linen that need improvement for the customer’s convenience.

Currently IKEA treat a smaller range of their bed linen with easy care finishing. This treatment provides textiles with varied properties, which are, among others, resistance to creasing and to prevent fibrillation of the lyocell fibre in products containing this particular fibre. [29] (see paragraph “3.5.1 Lyocell”)

Today IKEA is using the chemical company BASF as one of their suppliers of the resin for easy care finishing. As mentioned earlier, this treatment is conducted on a smaller range of bed linen offered in store today. [29]

1.2 Description of the company

IKEA’s business idea is to offer furniture for the many people. Their designers and product developers work hard to ensure that their products meet their customer’s everyday needs without any unnecessary detail. The idea behind all of IKEA’s products is that to a low price, the customer will be offered well designed, functional home furnishing products. [15]

“We know that sometimes we are a part of the problem. Therefore, we work hard to become a part of the solution. We weigh the benefits against the disadvantages, and examine and change things all the time.” [16] IKEA work to ensure that products and materials are designed to minimize any negative impact on the environment, and that they are safe for customers from a health perspective. [17]

1.2.1 History and facts

The company IKEA was founded in 1943 by seventeen-year-old Ingvar Kamprad, who lived in the woods of the Swedish region Småland. This young entrepreneur started his carrier when he was 10 years old, selling matches, and soon enough supplemented the business by selling more products such as greeting cards, seeds, Christmas decorations and pens. [18]
The company soon grew in popularity and the furniture sales started in 1948 and at that time it was the local furniture makers that stood for the production. It was not until the year 1956 that IKEA started to produce its own design. The products were, as today, sold unassembled in flat packages to minimize costs so that the many people could afford IKEA’s products. [19]

Since the foundation of IKEA, the company has only grown bigger and has developed into a large company with 123 000 employees in 25 countries and with annual sales of over 21.5 billion Euros. [20] In the year of 1986 Ingvar Kamprad stepped down from his role as CEO but he has continued to have great influence in the company, not only as owner. [21]

1.2.2 Textile products and production
IKEA, as one of the world’s biggest furniture companies, consume a great amount of textile fabrics each year. The product range within IKEA’s textile department is wide. Here you can find; bedroom products; kitchen textiles; sofas; and quilts, among others. [23] The textile products offered make out 20 % of the total assortment of IKEA, and the bed linen make out 5 % of the total assortment. The easy care finishing process in the textile production is made in different countries, situated in both Europe and Asia. [29]

1.3 Purpose
The purpose of this report is to scan alternative chemicals for crease resistant finishing that lives up to IKEA’s demands, and from the scanning and evaluation, choose and present three resins for IKEA to use in crease resistant finishing of their bed linen. The demands IKEA has specified for their bed linen concern the maximum amount of formaldehyde emission of the fabric, the tensile strength, the dimensional change after washing, and the deviation from indicated weight on fabric.

The purpose is also to find a way of determining the quality of the crease resistant finishing. This only concerns the visual crease appearance of the fabric and should result in a quality test that IKEA can include in their specification for requirement of finished textile products.

1.4 Problem and questions at issue
IKEA’s demands on the amount of formaldehyde in their bed linen cannot rise above 20ppm, so which resin chemicals have the lowest amount of formaldehyde?

Which resin chemicals fits IKEA’s demands on quality? IKEA has a demand that expects easy care finished textiles to have persisting crease resistant features after 10 washes, however their own suggested washing durability test goes up to 50 washes, and preferably this suggested demand will be achieved in this project.

What quality testing is relevant for crease resistant finished textiles?

What method can IKEA use to determine the level of creasing on the resin treated textile? Is there more than one method, and can developments be made on existing methods?

1.5 Subject limitations
There are several ways to prepare crease resistant finish on textiles. This project is focusing on impregnation of the chemicals on the textile. IKEA has a wide range of materials in their bed textile assortment but in this project focus is put on two qualities. The laboratory tests, and the evaluation of the most suitable crease resistant resins, will be done on bed linen in qualities of 100 % cotton and 50/50 % lyocell/cotton.
It is important to do quality tests on the ready prepared textile. IKEA has a laboratory in Älmhult where their quality testing is done. In this report quality testing will be limited to those that are relevant for the planned test specimens treated with crease resistant resins. When planning the laboratory work, considered is the fact that some tests cannot be done due to lack of instruments at the laboratory at the Swedish School of Textiles in Borås. The quality tests that will be conducted in this project are; the amount of formaldehyde content of the fabric, the tensile strength, the dimensional change after washing, the deviation from indicated weight of fabric, and the smoothness appearance after washing. A closer description of these tests can be found in paragraph 2.3.1 Test methods – ISO standard.

When determining the amount of released formaldehyde in the textiles, a calculation of values, received in the test process, will be conducted. However, due to lack of instruments at the Swedish School of Textiles, only one part of the calculation is possible to execute. For this reason the report will not present the exact value of released formaldehyde in the treated fabric specimen. It will only indicate whether the treated fabrics contain a higher or lower amount of formaldehyde, in relation to each other.

Phrase explanation:

**Easy care finishing** – Textile finishing concerning; crease resistance; preventing the occurrence of fibre fibrillation; and iron free features etc.

**Crease resistant finishing** – Finishing concerning crease resistance of the textile. This feature also provides preventing of fibre fibrillation and provides iron free features.

In the following report both of these phrases will be used. They have in this report the same meaning and the different phrase’s are based on the same chemical usage and finishing process and creates the same features for treated materials.
2. Method

This chapter will present the different methods used in this project for IKEA, which include both literature studies and planning of the experimental part of the project.

2.1 Literature studies

This project included an extensive literature study. This is to get a greater picture on the subject and the background of this topic. These literature studies were conducted on books, both physical and electronic material. Databases was used to search for scientific articles, this for finding relevant facts based on scientific studies. The databases used were reachable for students at the Swedish School of Textiles.

Crucial for this project is the information from the company IKEA, as the main task of this project is the practical testing of crease resistant resins, in which the tests should be conducted according to standards at IKEA.

All sources used in this report were critically viewed, and high emphasis was put on searching for sources that are relatively newly published. Fact that was found on the Internet was controlled of its author and its relevance before used.

2.2 Practical information studies

To gather information relevant for the practical part of this project, an interview was conducted both with the mentors of this project, and also with people working in the quality test laboratory at IKEA. The interviews were conducted face to face at different meetings at IKEA with the mentors, Anna Palmberg and Marius Lehadus. A tour in the laboratory was done to get an overview of the quality testing that is conducted at the IKEA at the test laboratory. These meetings provided us with much needed information regarding the product development and testing of products at IoS.

For the scanning of resins, potential suppliers of crease resistant resins were contacted, both in Sweden but also from other countries around the world. This contact has mainly been carried out by e-mail and phone. Recommendations and presentations of the different chemicals have been carefully analyzed with a critical point of view, because of the potential manipulation from the suppliers, due to different economical profit that would benefit the chosen supplier.

2.3 Experimental design

After gathering all needed data the practical work was initiated, conducted during a three-week period. During this period, preparation of resin on the two different fabric qualities was done. Every chemical received from contacted suppliers were prepared on test pieces of the two different fabrics received from IKEA, these material pieces were in the size of 28x40 cm. Subsequently the main work was conducted in form of various quality tests, which were:

- ISO 14184-1; Textiles - Determination of formaldehyde
- ISO 6330; Textiles - Domestic washing and drying procedures for textile testing
- SS-ISO 7768; Textiles - Test method for assessing the smoothness appearance of fabrics after cleansing Smoothness appearance after washing
- ISO 3801; Textiles - Determination of mass per unit length and mass per unit area
• ISO 3759; Textiles - Preparation, marking and measuring of fabric specimens and garments in tests for determination of dimensional change
• ISO 13934-1; Textiles - Tensile properties of fabrics

(These test methods will be introduced and more thoroughly proclaimed further down in this paragraph.)

The quality tests were conducted at the laboratory at both the Swedish School of Textiles and the School of Engineering in Borås.

Finally the laboratory work was analyzed and critically viewed because of the potential error measurements that may have occurred while working with the required instruments for this project.

2.3.1 Test methods - ISO standard

ISO 14184-1; Textiles - Determination of formaldehyde

This test method is done for measuring the content of formaldehyde in a ready treated fabric. In this project, the testing of formaldehyde will be conducted by a method called “The Water extraction method”. The amount of released formaldehyde will be measured partly by hydrolysis through water extraction, and partly by measuring the absorbance of the test liquid with a spectrophotometer. To get an exact value of how much released formaldehyde (ppm) the tested fabric contains, a standard curve has to be developed, and this work will not be done for this project due to the time limit the project has. The absorbency of each test liquid will be presented and this will give an indication on whether the formaldehyde content is higher or lower compared to the other resins evaluated.

ISO 6330; Textiles - Domestic washing and drying procedures for textile testing

In this test method two washing procedures are possible to use, type A with a front-loading washing machine and type B with a top-loading washing machine. For this project type A is used. For the washing procedure the test specimens will be washed with added ballast, to make the total load of dry material to 2 ± 0,1 kg (according to procedure no. 2A). The specimens and ballast will be washed in 60°C degrees (according to procedure no. 2). After wash no. 1 the specimens are hang dried for the first evaluation of smoothness appearance, according to the standard in SS-ISO 7768. And after the evaluation, the specimens are tumble-dried in between each washing; they are washed 10 times.

SS-ISO 7768; Textiles - Test method for assessing the smoothness appearance of fabrics after cleansing

When testing the smoothness appearance in this project, the “American Association of Textile Chemists and Colourists” method will be used. This test method can be evaluated after one or several washes of the specimen. Each specimen is cleaned according to machine type A procedure in SS-EN ISO 6330. For evaluation of the specimen, five three-dimensional smoothness appearance replicas will be used, rated from 1 - 5, where 1 appears heavily creased and 5 appears with seemingly smooth lumps. (Figure 3: the AATCC test replicas, p.22) Before the evaluation of the test specimens they should be conditioned for at least 4 hours. The test specimen will be put next to the replicas on a black background, and a comparison will then be made. This process will be conducted in a dark room, and the test specimen and replicas will be light up by a standardized lamp. Three persons, standing 1 - 2 meters away from the test specimen and replicas, will individually rate the creasing of the test specimen and a joint mean value will be taken.
When conducting this evaluation the conditioning according to the standard is not possible to conduct. The test specimens will be kept flat and separate for 12 hour in indoor conditions before the evaluation.

ISO 3801; Textiles - Determination of mass per unit length and mass per unit area
In this method the weight of the fabric is measured before resin treatment and after resin treatment. The result is analysed and evaluated. For the weight samples a circular sample cutter is used, this gives an exact fabric sample size of 1 dm². This sample is then weighed in an electric precision balance scale. Three samples of each combination of chemical/fabric will be cut out and a mean value will be taken.

ISO 3759; Textiles - Preparation, marking and measuring of fabric specimens and garments in tests for determination of dimensional change
The dimensional change test method evaluation can be conducted after one or several washes. The washes are done according to the type A washing procedure in SS-EN ISO 6330. When the dimensional stability is being determined the load of test specimens should not be more then the load of ballast (total load of dry material should be 2 ± 0,1 kg, according to ISO 6330; Textiles - Domestic washing and drying procedures for textile testing). For shrinkage marks, a smaller crease marking plate (175 mm) is used. After washing the specimens, the dimensional change is measured with a ruler, measuring the shrinkage or the stretch; both in warp direction and weft direction.

ISO 13934-1; Textiles - Tensile properties of fabrics
The tensile strength test method is conducted on a Universal tensile tester. For an accurate measure value, the test should be conducted on several fabric specimens. The machine setting varies, and is dependent on tested material and the size of the specimens. Required settings are:

- Load range (N) [50 - 5000]
- Extension range (mm) [0,1 - 2000]
- Gauge length (mm) [1 - 1000]
- Test speed (mm/min) [0,001 - 1000]
- Approach speed (mm/min) [0,001 - 1000]
- Preload (N) [0 - 500]

The test is conducted in both warp and weft direction.

2.4 Materials
The two materials that will be included in this project are: 100 % cotton and 50/50 % cotton/lyocell. The first material is a 100% cotton fabric, spun of combed cotton and the construction is sateen 4/1. The second material is cotton/lyocell and this yarn is spun of carded cotton and the construction of this fabric is plain weave 1/1.

The cotton material in the bed-linen, untreated with crease resistant finish, that are offered at IKEA today, has a total process flow of singeing, desizing, washing, cold bleaching, mercerising, washing, stentering, dying, washing, softener finishing, and calendering. The material that will be finished in this project has only gone through a part of this process flow; singeing; desizing; washing; cold bleaching; mercerising; washing; and drying.

The cotton/lyocell material is as mentioned earlier in the report, treated with easy care chemicals today and the total process flow is; singeing; cold bleaching; washing; alkaline treatment; washing; stentering; printing; steaming; washing; finish and resin treatment; and stentering. The cotton/lyocell fabric received for this project was only processed with;
singeing; cold bleaching; washing; alkaline treatment; washing; and stentering. (Technical
description received from IoS)

2.5 Chemicals
The resin chemicals were obtained from 3 chemical suppliers, found as a result of the
suppliers scan. The resins tested at the laboratory at the Swedish School of Textiles were all
DMDHEU reactant resins. Acid catalysts and recommended softeners, were obtained from
the same supplier as the resin.
For testing the content of formaldehyde the chemical Dimedon was obtained by the School of
Engineering in Borås. All the other chemicals were general laboratory chemicals, also
provided by the School of Engineering in Borås.
3. Theory

In this chapter a general presentation of chemical finishing is introduced. It will give an overview of the history of the chemical easy care resin, it will provide the reader with the range of different resins used on the market today, the properties that an easy care resin requires, and give a closer explanation of the chemical compound formaldehyde. The chapter will also present five companies and their resins suitable for IKEA’s crease resistant finishing. And finally the material used in IKEA’s bed linen (cotton and lyocell) will be presented.

3.1 Chemical finishing (continuous process)

Chemical finishing can also be referred to as “wet finishing” and is done to achieve a desired fabric property. The finishing is for the most part done after bleaching and dyeing, but before the sewing part of the garment or textile product. Chemical finishing can be durable or non-durable. Durable finishing is when the prepared fabric can be washed several times after finishing without loosing its special properties. Non-durable finishing is preferable for fabrics that are not laundered, i.e. technical textiles. [1]

When treating a fabric with chemical finishing, three different steps are fundamental; application; drying; and curing. The curing step is done for the durable goods and is usually an additional heating step.

These different steps have different methods to be applied:

Padding

This is the most common way of applying the chemical on the fabric in a continuous process. The padding machine is pressing the material with the formulation through two squeeze rolls. The amount (%) of wet-pick up in the padder differs depending on different factors, such as material, machine and process. [2]

Drying

The drying can be done by mechanical methods such as squeezing, centrifugal extraction, or vacuum extraction. These methods only remove the moisture that is loosely attached to the material. For removal of the moisture that is trapped within the fibres, more energy is needed for vaporization of the water. [2]

This is achieved with a stenter frame. The stenter frame (which the fabric is attached to) is passed over with heated air in desirable degrees. This is a very popular drying method due to the high process speed and the control of fabric dimensions during drying. [1]

Curing

The curing phase can be done with the same equipment that is used for the drying phase. Very important for the curing phase is that the temperature of the fabric cannot exceed 100°C until all of the moisture has been removed. The drying and curing can be done at the same time, this is called shock-curing process. This is a risky curing alternative due to difficulties of determining when the fabric is dried. This can contribute to over curing or under curing of the fabric. [1]
3.2 Easy Care Chemicals

3.2.1 History
In the early 1920’s the first simple urea-formaldehyde resin for easy care and crease resistant treatment was created and patented. At this time a resin chemical consisting of phenol-formaldehyde also existed but this chemical was early discounted due to the colour it left on the textiles. The finishing process for these resins was the same as it is nowadays. It required both an acid catalyst and a heating process for curing and drying.

After this resin was issued, a great deal of different resins was created, all containing formaldehyde:

- “Urea – formaldehyde”
- “Highly condensed urea – formaldehyde”
- “Methylated urea – formaldehyde”
- “Melamine – formaldehyde”
- “Methylated melamine – formaldehyde”
- “Ethylene urea – formaldehyde”
- “Heterocyclic cross linking agents based on melamine – formaldehyde”
- “Glycol based reactants and derivatives thereof”

All these resins have contributed to today’s standards of easy care chemicals. [3; p. 173-174]

3.2.2 Easy Care chemicals required properties
These are the required standard properties that all easy care chemicals must provide:

1. “Dry and wet crease resistance”
2. “Good dimensional stability”
3. “Little loss in physical properties (i.e. tensile and abrasion)”
4. “Compatibility with other finishing agents (e.g. water-repellent, softeners, optical brightening agent)”
5. “Minimum effect on handle”
6. “Little effect on dye or print shade or the light-fastness of the dye”
7. “Little effect on rub fastness of dye or print”
8. “No effect on the whiteness of the fabric”
9. “As low as possible formaldehyde release”
10. “Good environmental condition both in the application of the resin and the final making up of the fabric when finished”
11. “Ease of application and low cost add-on factor in both chemical and application cost.” [3: p.174]

3.2.3 Different forms of easy care chemical resins

*Urea – formaldehyde resin*
This resin was the first one to be developed in the early 1920’s and contained a high amount of free formaldehyde and therefore the fabric had to be washed after finishing. When this resin was developed, the fibre viscose was first entering the market and without the resin this fibre wouldn’t have gotten the same popularity that it did. [3]
Methylated urea – formaldehyde resin
This resin entered the market in the 1950’s and it did so along with the nylon fibre. This resin was well functional with the new fibre, nylon, and could create a stiffness to it that was popular. The resin reacted differently with the cotton fibre compared to the nylon fibre. With cotton the resin entered the fibre and when catalyzed it created a polymeric network inside the fibre that prevented the fibre to shrink when washed. With the nylon fibre the result was different, the resin created a shell-like surface on top of the fibre and made it stiff. This resin had a better washing stability and better crease stability. [3]

Melamine resin
This resin was created to give cotton and viscose a fuller and greater handle compared to regular urea – formaldehyde resins. [3]

Reactant resins
This resin raised in popularity when the cellulose-synthetic fibre got to be more and more popular. This resin, in contrary to simple urea-formaldehyde resin, doesn’t give the synthetic fibre a stiff handle because it only reacts with the cellulose fibre. It also has lower formaldehyde content compared to urea-formaldehyde and melamine resins. Another benefit this resin has is that the amount of resin needed in the finishing process, isn’t as high as the amount of other resins on the market. A big difference between urea-formaldehyde resins and melamine resins are that the reactant resin, urea-formaldehyde, actually reacts with the fibre, it doesn’t create a polymeric network in the fibre as others resins does. The most popular resin is the DMDHEU resin. With help from an acid catalyst, this resin creates linkages to the cellulose fibres’ OH groups. [3]

The DMDHEU resin, used for easy care finishing with a lower formaldehyde content, has since the 1970’s been more important than urea formaldehyde and melamine formaldehyde resins. [6]

3.2.4 Easy care chemicals for bed linen (finishing process)
When preparing fabrics with easy care chemicals there are four steps to be considered:

1. “All resins require acidic or neutral pH conditions on the fabric to carry out a cure. It is recommended to add an acid to the last rinse-off off the fabric to ensure these conditions.”
2. “The fabric should be fully dried before adding the resin.”
3. “The amount of resin added on the fabric should be as low as possible, this is achieved by having a high pressure on the pad-batch. It is also important not to dry the fabric to fast, because this creates a stiff handle. One suggestion is to dry the fabric in a five bay stenter where the first compartment has about 100-120°C and then the heating in each compartment is gradually increased up until 180°C.”
4. “There are a lot of different catalysts used to different resin systems.” [3: p.185 - 186]

3.3 Formaldehyde
Formaldehyde is one of the most widely produced and used chemicals in the world. At high exposure of formaldehyde, the chemical can cause tumours, and is suspected to be carcinogens. When human skin is repeatedly exposed to formaldehyde it can get irritated, and in some cases allergies can be developed. Dermal contact may cause eczema, blisters, and flanky, dry skin that can itch or burn. [27]

Formaldehyde-containing resins may, under certain conditions, chemically degrade and release free amounts of formaldehyde. For this reason, many countries have introduced
restrictions of formaldehyde in products by law. The releasing differs in various conditions, such as heat and humidity. [27]

There are two analytical tests to determine the level of formaldehyde in textiles, both commonly used in the textile industry; the Japanese Law 112 and the American Association of Textile Chemists and Colorists (AATCC) 112 test. The Japanese Law 112, also known as the Water Extraction Method (ISO 14184-1), is the test method IKEA uses to determine the content of formaldehyde in their textile products, and have also been practised in this project. This test was developed to measure the amount of formaldehyde that may be released by textiles that may come into contact with the skin. (Paragraph: 2.3.1 Test methods - ISO standard; Headline: ISO 14184-1; Textiles - Determination of formaldehyde.) The American Association of Textile Chemists and Colorists (AATCC) 112 test was developed to measure the amount of formaldehyde that may be released from textiles during extended storage or hot and humid conditions. [27]

3.4 Suppliers and their chemicals

The following different chemicals, from suppliers that have been contacted for this project, will be presented. The presentation is based on the suppliers’ own technical information of the chemicals. The information presented in this paragraph is based on the technical descriptions received from the suppliers of each chemical. (The reader can find further information of the different suppliers in Appendix 1 and technical descriptions in Appendix 2-11)

Texchem UK Ltd.

Resin PLF – According to the manufacturer, this is a pre-catalysed resin that provides ultra low formaldehyde content. It is suitable for cellulosic fabrics and their blends with synthetic fabrics.

Texfin CR – According to the manufacturer, this is a combined resin, catalyst and softener. Texfin CR is used for easy care finishing, and in this case suitable for crease resistant treatment. The pre-determined amounts of the different chemicals mixed in this product, is to give the best features and the optimum results with the finishing. This resin is typically used for cellulosic materials and their blends.

Clariant

Arkofix NZF - According to the manufacturer, this is a cross linking agent for cellulosic fabrics and their blends. It provides very good dimensional stability and it gives a formaldehyde free finishing.

Arkofix ELF – According to the manufacturer, this resin gives an ultra low formaldehyde containing finishing and it provides very good crease and shrinkage resistance and also shows very good tear and tensile strength.

BASF

Fixapret ECO – According to the manufacturer, this resin is a cross linking agent for extremely low formaldehyde content for easy care finishing.

Fixapret ECL – No technical description received
Omnova

*Permafresh Silver* – According to the manufacturer, this is a non-formaldehyde resin that provides very good performance on a variety of fabrics.

*Permafresh SWT* – According to the manufacturer, this chemical is still in the process of development, and therefore, no technical description is available.

*Permafresh CSI-2* – According to the manufacturer, this resin provides durable shrinkage control, smoothness, and colour retention. The formaldehyde release of the fabric is ultra-low, meeting Oeko-tex standards.

Diazoo

*Quecodur FFL Plus* – According to the manufacturer, this is an integrated resin and catalyst system. This means that no catalyst is needed in the recipe. It provides a formaldehyde free easy-care finishing at a low temperature.

*Quecodur SLF* – According to the manufacturer, this resin also has an integrated catalyst system. It gives a low formaldehyde content that meets Oeko-tex standards.

### 3.5 Textile materials and chemicals

Currently IKEA has a wide range of bed linen in their bed textile department. The material assortment is; cotton, flax, lyocell, lyocell/cotton, and polyester/cotton. [24] This report is limited to two qualities of bed linen, cotton and cotton/lyocell.

#### 3.5.1 Cotton

The cotton fibre is cultivated in various countries around the world such as the United States, China, India, Brazil, Egypt, Turkey, Mexico and the Sudan. In all of these regions there are at least six frost-free months per year, and during this time the sun shines twelve hours per day. These conditions are crucial for cotton to be able to grow. It rains 7 - 12 centimetres each month, or adequate irrigation can be supplied. And when it is time for the fibre to mature, the weather needs to be dry. [4]

The fibres grow in a green ovary, which is left when the flower falls from the plant. The ovary enlarges as the fibres grow and in this stage the fibres are moist. When the ovary is mature it begins to open and the moist evaporates, forcing the fibres’ cell walls to collapse and the classic kidney-shape and lengthwise twist is formed. The cotton fibre can easily be identified in a microscope, seeing as no other fibre has a similar structure. [4]

Cotton is made from 100 % cellulose, and is a hydrophilic fibre, which means that at 65 % relative humidity and 21°C, its moisture regain is 8,5 %. For this reason cotton is a very comfortable fibre as it absorbs water vapour emitted from the body, leaving the skin dry. The polymers in the cotton fibre form a highly crystalline structure with numerous strong cross-linked hydrogen bonds. These cross-linking bonds are the reason that cotton does not crease as much in dry condition. Due to the crystalline structure cotton is one of the few fibres that also increase tenacity in wet conditions, up to 10 – 20 % greater tenacity compared to its dry tenacity. However, the cross-linking bonds tend to break when exposed to twisting or folding in wet condition. To prevent these bonds from breaking in wet condition, the cotton fabric can be treated with a crease resistant finish. [4, 7] This finishing can, however, cause the fabric to
loose tensile strength, due to the acidic catalyst needed in many crease resistant resin recipes. When cotton is exposed to acid, the molecular chains tend break, causing the fabric to lose tensile strength. [8]

The staple length of the cotton fibre can differ from 2,1 – 6,4 centimetres. The longer the staple the smaller the diameter is and the higher the quality is. The most common cotton is the “Upland cotton” from America (staple length 2,1 – 3,2 centimetres). Egyptian cotton is a high quality cotton with staple length 3,8 – 4,4 centimetres. However the finest cotton, hence the most expensive, is the Sea Island cotton with staple length 3,5 – 6,4 centimetres. The Sea Island cotton was first grown in the islands off the coast of South Carolina and Georgia in America, however nowadays it is only grown in limited quantities. [4]

3.5.2 Lyocell
Lyocell is an artificial fibre made from 100 % cellulose, produced as a more environmentally conscious alternative to viscose. Since the late 1970’s the development towards the lyocell fibre has been a project among rayon fibre manufacturers, and the first commercial sample was produced in 1984. [5, 4, 8]

When looking in a microscope the fibre cross-section shape is round, giving the fibre high lustre. Lyocell can be manufactured in both filament fibres and staple fibres. [4] Due to the smooth surface and small denier of the fibre, lyocell fabrics are known to be comfortable to wear. The moisture regain is 11,5 % in the standard environment of 21°C and 65 % relative humidity. [4]

In the production of lyocell the pulp dissolves in a solvent made from amine oxide (N-Methylmorpholin N-oxide), which is non-toxic and can be recycled in the process. When solving the pulp a viscous mass is formed. This viscous mass is then extruded and spun into a spinning bath, containing only water and a low concentration of solvent. The fibre is stretched and then washed. The solvent in the spinning bath is recovered by letting the water evaporate. Waste products are minimal and non-hazardous in the manufacturing of lyocell, which contributes to making the process environmentally friendly. [4, 9, 10]

The lyocell fibre is highly crystalline and highly oriented, however it lacks lateral cohesion among the polymers, which gives the fibre a tendency to fibrillate. When fibrillation occurs thin parts (fibrils) of the fibre is split lengthwise along the fibre axis, at the surface of the fibre. The fibrillation occurs mostly when subjected to mechanical forces in wet conditions. When the fibre absorbs water it swells and forces the hydrogen bonds that link the crystalline units to break. The broken bond causes the fibrils to peel away from the main fibre. Fibrillation affects the surface structure of the fabric and causes the fabric to crease as well as turning it greyish.
To prevent lyocell fabrics from fibrillation, a resin treatment can be made. In addition to prevent fibrillation, the resin also gives the fabric improved dimensional stability and enhance the crease recover. [4, 8]

3.5.3. Chemical
One of the resins used at IKEA is trademarked as Fixapret NF, and is provided by the company BASF. [29] Fixapret NF is a trade name for the cross-linking agent or easy care resin, Dimethyldihydroxyethylene urea. The chemical is a clear, yellowish, aqueous liquid. (Appendix 3) BASF describes the chemical Fixapret NF on their web page as a “formaldehyde-free textile resin for easy care finishing of woven and knitted fabrics produced from cellulosic fibres and their blends. Fabrics finished with this product demonstrate a softer
hand and greater strength retention than typical resins that contain formaldehyde”.

3.6 Alternative evaluations of smoothness appearance
As described in paragraph “2.3.1 Test methods - ISO standard” under headline “SS-ISO 7768; Textiles - Test method for assessing the smoothness appearance of fabrics after cleansing Smoothness appearance after washing”, the method for testing the smoothness appearance in this project is the AATCC test method, where after standardized washing and drying conditions, the test specimens are compared to five three-dimensional replica plates. There are however a few more ways to test the amount of creasing of textiles. Attempts to digitalize the testing of creasing of textiles have been made. One way, is by using a laser probe to measure the three-dimensional roughness that is the creasing, i.e. the height variations in the textile. The laser probes conduct one measure at a time, and therefore have to measure in both warp direction and weft direction. This method is effective on fabric specimen, however, too slow for industrial use.

Another digitalized method is by using a CCD camera to decide the amount of wrinkles on textiles. The CCD camera is dependent on light sources, which makes it unassertive when analysing printed fabrics, however, effective when analysing unprinted fabrics. The camera should be fixed and placed above the fabric specimen, and two or more parallel light beams from inclined directions should shine on the specimen. The CCD camera will then register the different shades reflected in the fabric specimen.

The advantage of these digitalized methods is the fact that they are not dependent on the vision ability of the people comparing the fabric specimen to the AATCC replicas. [11, 12, 13, 14]
4. Experimental work

This chapter will present the experimental work of this project and the details regarding this part. Due to confidential test instructions from IKEA, the measuring of released formaldehyde content will not be described with exact details.

The laboratory work is divided into three major parts. The work will begin at the colouring and finishing laboratory at The Swedish school of Textiles, where the finishing of the textile by received chemicals will be conducted, along with testing and evaluation of smoothness appearance after washing, deviation of weight, and dimensional change after washing. Afterwards, an extensive work at the chemistry laboratory at The School of Engineering will be done, this for testing the formaldehyde content of the finished textiles. At last, testing the tensile strength of the finished textiles will be conducted at the polymeric laboratory at The School of Engineering.

4.1 Easy care chemicals evaluated

In table I, the reader can get an overview of the chemicals chosen to work with in this project. The chemicals were provided from three different chemical suppliers, Omnova from USA, Texchem from UK, and Diazo from Sweden.

Table I: Suppliers and chemicals evaluated

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Chemical no. 1</th>
<th>Chemical no. 2</th>
<th>Chemical no. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omnova</td>
<td>Permafresh® Silver</td>
<td>Permafresh® CSI-2</td>
<td>Permafresh® SWT</td>
</tr>
<tr>
<td>Texchem</td>
<td>Resin PLF</td>
<td>Texfin® CR</td>
<td></td>
</tr>
<tr>
<td>Diazo</td>
<td>Quecodur SLF Plus</td>
<td>Quecodur FFL Plus</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Laboratory work

As mentioned the finishing of the textiles is conducted at the colouring and finishing laboratory at the Swedish School of Textiles in Borås. The finishing process is divided into groups of each chemical (seen in Table I). The recipe used for each chemical is a recommended recipe from the specific supplier providing the chemical. Eight specimens of each fabric are impregnated with the chemical in a foulard, (Figure 1: Foulard from the Swedish School of Textiles) and directly put in a stenter (Figure 2: Stenter from the laboratory at the Swedish School of Textiles) for drying and curing. The time and temperature varies from chemical to chemical, and are based on the recipes (see Table II, Appendix 13). When impregnating the fabric samples, the right amount of chemical needs to be used. Adjustments in the pick-up can be done in the foulard, which regulates the amount of chemical forced on the fabric. The pick-up used for each chemical in this project is based on the recipes (see Table II, Appendix 13). After the chemical finishing, the fabric specimens are washed one time in a standardized washing machine.
For the evaluation of the smoothness appearance, the fabric specimens are laid out separately on a table one day before the evaluation. Subsequently, the evaluation is done on five test pieces of each fabric/chemical combination, to be able to present an accurate measurement. In total, 70 test pieces are evaluated.

Five test pieces, untreated with easy care resin, of the two qualities used in this project (in total, 10 test pieces), are also washed one time and evaluated according to the same test method, this for determining the creasing of the fabric untreated with crease resistant resin and being able to compare them to the easy care resin treated fabric specimens.

The same test evaluation is conducted on the fabric specimens once more after being washed 10 times, this to ensure the durability of the chemicals on the fabric. The test specimens are compared to the replicas in figure 3. (For further information of the smoothness appearance after washing SS-EN ISO 6330, go to paragraph “2.3.1 Test methods – ISO standards”)

Three test samples, from each fabric/chemical combination, are cut out with a circular cutter for measuring the deviation of weight. In a total 42 test pieces are handled, excluding 6 test pieces untreated with easy care chemicals, which are also cut out and weighed. A mean value is noted for each combination of fabric/chemical. This value will be compared to the weight of the fabric untreated with crease resistant resin. (For further information of the deviation of weight ISO 3801, go to paragraph “2.3.1 Test methods – ISO standards”)

On the same fabric specimens that the smoothness appearance is evaluated on, the dimensional change is also measured. The test specimens are in the size of 28x40 centimetres. The measurement is done on three places on each piece for a more accurate measuring. Here, a mean value of the measurements is taken. This test is done on five specimens of each fabric/chemical combination. The test specimen can be seen in figure 4. In a total 70 resin treated test pieces and 10 untreated test pieces are handled in this test method. (For further information of the dimensional change after washing SS-EN ISO 3759, go to paragraph “2.3.1 Test methods – ISO standards”)

The test for measuring the content of formaldehyde is conducted at the School of Engineering in Borås. The test is done on specimens that have not been washed after resin treatment. A small amount of each specimen is weighed and cut into small square pieces before the test, and kept in well-closed plastic bags, to prevent conditioning of the fabrics.

First the small test pieces is mixed with distilled water and put in a shaking water bath for 60 minutes, in a special temperature, at a rotation speed of 60 rpm. After this the mixture of fabric and distilled water is filtrated by using a fibreglass filter. The mixture is then left standing for a while in room temperature. After this the test liquid is mixed with Acetyl-
acetone solution in test tubes. (Figure 5: Formaldehyde content quality test) Double tests are made on each fabric/chemical combination, and double tests are made on each mixture, which makes it a total of 4 tests per chemical/fabric combination. One blind test for each fabric/chemical combination is also made which gives a total of 70 test specimens. Instead of test liquid, water is used in the blind tests mixed with Acetyl-acetone solution as before.

When all tests are made, they are each put in a small plastic cuvette and read at 412 nm in a spectrophotometer, seen in figure 6, with a reference test made by distilled water. The spectrophotometer decides the reflection of the test liquid and with this absorbance value the amount of released formaldehyde in the liquid can be decided.

Double water tests, with water and test liquid, is made to eliminate the impurities that might have an impact on the test liquid. This is done on each mixture of fabric and distilled water. Also, tests with the chemical Dimedone is done on every test liquid, this to ensure that the measured absorbance is a result of the formaldehyde content and not some other colour pigments. Dimedone reacts with formaldehyde, making the colour caused by formaldehyde to disappear. The water tests and the Dimedone tests make a total of 84 control tests. These tests are also read in the spectrophotometer. (For further information of the determining of formaldehyde content ISO 14184-1, go to paragraph “2.3.1 Test methods – ISO standards”)

There are two steps in the process of calculating the content of released formaldehyde in textiles. The first step gives the value of the absorbance in the test liquid:

\[ A = A_s - A_b - A_0 \]

A – the total absorbance
A\(_s\) – the absorbance of the sample
A\(_b\) – the absorbance of the blind test
A\(_0\) – the absorbance of the water test
(see paragraph “5.4 Formaldehyde content (ISO 14184-1)”, table VI)

The second step is used when calculating the concentration of formaldehyde in the test liquid:

Formaldehyde (ppm) = \( (A \times f \times V) / W \)

f = factor from standard curve
V = 100 ml
W = the weight of test specimen (g)

As described in “subject limitations” (paragraph 1.5), the second step in calculating the content of formaldehyde has not been conducted in this report. However, the formula gives an indication to that the absorbance is linear with the formaldehyde content of the test liquid. Therefore, by only viewing the absorbance value of the different test liquids, the value will
reveal whether the treated fabrics contain a higher or lower amount of formaldehyde, in relation to each other.

The testing of tensile strength is also conducted at the School of Engineering in Borås, and is illustrated in figure 7. The test is conducted on 10 specimens, from each fabric/chemical composition, in a size of 2x10 cm and they are tested both in the warp direction (5 specimens) and in the weft direction (5 specimens). This is to find a mean value and create an accurate measuring. The test is done on crease resistant treated fabric that has not been washed and also on fabric specimen untreated with crease resistant resin. In total the test is conducted on 160 test pieces.

The machine for testing tensile strength at the School of Engineering is a Universal tensile tester, called Tinius Olsen H10Kt, and a load of 5kN is used for the test specimens in this project. (Figure 8: Universal tensile tester from the laboratory at the School of Engineering in Borås)

The settings for this machine, in this project, is:

• Load range 200N (50 - 5000)
• Extension range 100 mm (0,1 - 2000)
• Gauge length 25 mm (1 - 1000)
• Test speed 50 mm/min (0,001 - 1000)
• Approach speed 20 mm/min (0,001 - 1000)
• Preload 5 N (0 - 500)

(For further information of the tensile strength ISO 13934-1, go to paragraph “2.3.1 Test methods – ISO standards”)

Figure 7: Tensile strength quality test
Figure 8: Universal tensile tester from the laboratory at the School of Engineering in Borås
5. Result

In this chapter the result of the various quality testing will be presented. In a total, 14 different combinations of chemical and fabric with test result will be presented. The test results concern: smoothness appearance after washing, dimensional change after washing, tensile strength, formaldehyde content and deviation of indicated weight. Mentioned in following table is Sample A and Sample B, Sample A is a cotton weave untreated with crease resistant resin and Sample B is a cotton/lyocell weave untreated with crease resistant resin.

<table>
<thead>
<tr>
<th>Sample A</th>
<th>Cotton weave untreated with crease resistant resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample B</td>
<td>Cotton/lyocell weave untreated with crease resistant resin</td>
</tr>
</tbody>
</table>

5.1 Smoothness appearance after washing (Monsanto, SS-EN ISO 6330)

The evaluation of the smoothness appearance after washing, divided into chemicals and fabrics, are presented in table III. The smoothness scale has the range of 1 – 5, where 5 appear the most smooth, and 1 appears the least smooth. The evaluation is done both after wash no. 1 and wash no. 10.

As seen in table III the smoothness appearance evaluation after the first wash showed medium rating on all three chemicals from supplier Omnova; Permafresh Silver, Permafresh CSI-2 and Permafresh SWT. All, except for Permafresh CSI-2 treated on cotton weave, showed a decrease in the smoothness appearance evaluation after the ten washes and was rated medium to low.

Also presented in table III are chemicals from the company Diazo, who provided the resins Quecodur FFL and Quecodur SLF. Theses chemicals showed medium to high rating after the first wash but showed difficulties maintaining the quality of smoothness appearance after ten washes.

Finally the chemicals from the company Texchem is presented in table III (Texfin CR and Resin PLF). These two chemicals showed high ratings after the first wash and they showed the same result after the 10 washes as well.
Table III: Smoothness appearance after washing

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>Smoothness appearance after wash no. 1</th>
<th>Smoothness appearance after wash no. 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>2,5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>2,5</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>2</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>4</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>2,5</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>3</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>2,5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>4</td>
<td>3,5</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sample A</td>
<td>15</td>
<td>No easy care resin</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sample B</td>
<td>16</td>
<td>No easy care resin</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
5.2 Dimensional change after washing (SS-EN ISO 3759)

In Table IV the dimensional change after washing is presented. The shrinkage (-) or the stretch (+) is presented both in warp direction and in weft direction.

As seen in table IV the dimensional change evaluation done on the six combinations (no. 1 - 3 and no. 8 - 10) with chemicals from the supplier Omnova (Permafresh Silver, Permafresh CSI-2 and Permafresh SWT) showed very good results, low dimensional change in warp direction and low or none dimensional change in weft direction.

The chemicals distributed from supplier Diazo (no. 3 - 4 and no. 11 - 12) also showed low percentage of dimensional change, as well as the chemicals from Texchem; Texfin CR and Resin PLF.

As seen in table IV, none of the measured fabrics rise above IKEA’s standard in shrinkage and stretch, which is maximum 2% for stretch, and maximum 4% for shrinkage. (IKEA specification: Textiles – general requirements for finished products, Spec no. IOS-PRG-0023)

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>Dimensional change after wash no. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Warp (%)</td>
</tr>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>-1,0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>-0,75</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>-1,25</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>-1,5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>-1,0</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>-1,0</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>-2,0</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>-1,5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>-2,0</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>-1,5</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>-0,5</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>-0,5</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>-0,5</td>
</tr>
<tr>
<td>Sample A</td>
<td>15</td>
<td>No easy care resin</td>
<td>-3,0</td>
</tr>
<tr>
<td>Sample B</td>
<td>16</td>
<td>No easy care resin</td>
<td>-3,0</td>
</tr>
</tbody>
</table>
5.3 Tensile strength (ISO 13934-1)

In Table V the tensile strength testing is presented. As seen, Permafresh Silver, Permafresh CSI-2, Permafresh SWT from the supplier Omnova was found to be the strongest materials when testing the tensile strength. The retained percentage of yield force for the crease resistant treated materials with resin Permafresh SWT (no. 3 and no. 9) is between 82 % - 105 % in warp direction and 86 % - 55 % in weft direction.

Also presented in table V is the chemicals from the company Diazo; Quecodur FFL and Quecodur SLF. (no. 4 - 5 and no. 11 - 12) They showed varied results of retained strength of the crease resistant treated fabric. The chemicals from Diazo showed 82 % - 49 % of retained strength in warp direction and 73 % - 42 % of retained strength in weft direction. The chemicals from the supplier Texchem (Texfin CR and Resin PLF, no. 6 - 7 and no. 13 - 14) is the last two chemicals presented in the table. These chemicals showed the lowest percentage of retained strength, 68 % – 47 % in warp direction and 54 % - 35 % in weft direction.

<table>
<thead>
<tr>
<th>Table V: Tensile strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material: Tensile strength</td>
</tr>
<tr>
<td>No.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>Sample A</td>
</tr>
<tr>
<td>Sample B</td>
</tr>
</tbody>
</table>
5.4 Formaldehyde content (ISO 14184-1)

In table VI the absorbance of each chemical/fabric test liquid is presented. The absorbance of the sample is presented as \(A_s\), the absorbance of the blind test is presented as \(A_b\) and the absorbance of the water test is presented as \(A_0\). The total absorbance \((A)\) is \(A_s - A_b - A_0\). This table gives an indication of the content of formaldehyde being higher or lower when comparing the different chemical/fabric combinations to each other. This indication is based on the formula \((A \times f \times V) / W\), where \(f\) is a factor from a standard curve, \(V\) is the liquid volume (100 ml), and \(W\) is the weight of the test specimen (g). (For further information see paragraph: 4.2 “Laboratory work”).

As seen in table VI the three chemicals from the supplier Omnova; Permafresh Silver; Permafresh CSI-2; and Permafresh SWT, showed various amount of absorbency. The Permafresh Silver showed the lowest absorbency. The two chemicals provided from the supplier Diazo (Quecodur FFL and Quecodur SLF) showed both low and medium result. Quecodur FFL showed, similar to Permafresh Silver, extremely low absorbency. The chemicals from the supplier Texchem; Texfin CR; and Resin PLF, show the highest absorbency and this indicates that these chemicals have the highest content of formaldehyde.

Table VI: Formaldehyde content

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>(A_s)</th>
<th>(A_b)</th>
<th>(A_0)</th>
<th>(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>0,032</td>
<td>0,000</td>
<td>0,014</td>
<td>0,018</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>0,104</td>
<td>0,000</td>
<td>0,009</td>
<td>0,095</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>0,132</td>
<td>0,001</td>
<td>0,002</td>
<td>0,129</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>0,007</td>
<td>0,001</td>
<td>0,003</td>
<td>0,003</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>0,086</td>
<td>0,003</td>
<td>0,011</td>
<td>0,072</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>0,203</td>
<td>0,001</td>
<td>0,001</td>
<td>0,201</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>0,153</td>
<td>0,002</td>
<td>0,002</td>
<td>0,149</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>0,006</td>
<td>0,002</td>
<td>0,002</td>
<td>0,002</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>0,210</td>
<td>0,000</td>
<td>0,004</td>
<td>0,206</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>0,202</td>
<td>0,000</td>
<td>0,009</td>
<td>0,193</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>0,010</td>
<td>0,003</td>
<td>0,001</td>
<td>0,006</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>0,123</td>
<td>0,000</td>
<td>0,010</td>
<td>0,113</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>0,194</td>
<td>0,002</td>
<td>0,002</td>
<td>0,190</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>0,161</td>
<td>0,001</td>
<td>0,001</td>
<td>0,159</td>
</tr>
</tbody>
</table>
A control test was also conducted, produced by the chemical Dimedon. In Table VII, the results of the Dimedone tests are presented. These are all (except for Permafresh CSI-2 on cotton/lyocell - no. 9) very low, and indicate that it is the formaldehyde (and not other colouring factors) that caused the absorbency in earlier measurements.

Table VII: Dimedone tests

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>Ad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>0,002</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>0,005</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>0,009</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>0,011</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>0,011</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>0,005</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>0,006</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>0,002</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>0,016</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>0,009</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>0,010</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>0,002</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>0,006</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>0,004</td>
</tr>
</tbody>
</table>
5.5 Deviation from indicated weight (ISO 3801)

In table VIII the weight of the easy care resin treated fabrics is presented. This value is compared to fabric samples untreated with the resin (sample A and B). These measurements show the gain or loss of weight after crease resistant treatment. Measure values in this table show the weight of a potential product if a future product development, of presented chemicals and fabric, arises.

As seen in the table VIII the chemical/fabric combination; Permafresh CSI-2, cotton/lyocell (no. 9) increased with 7,81 g/m² which was the highest increase of all the chemicals and fabric combinations.

Table VIII: Deviation of indicated weight

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>Weight (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>118,23</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>119,4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>119,92</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>121,14</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>119,14</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>120,73</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>119,8</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>132,69</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>137,4</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>132,25</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>134,73</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>133,2</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>135,94</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>133,77</td>
</tr>
<tr>
<td>Sample A</td>
<td>15</td>
<td>No easy care resin</td>
<td>111,71</td>
</tr>
<tr>
<td>Sample B</td>
<td>16</td>
<td>No easy care resin</td>
<td>129,59</td>
</tr>
</tbody>
</table>
5.6 Development of the evaluation of smoothness appearance after washing

When evaluating the different crease resistant resins according to ISO standard SS-EN ISO 6330 (Smoothness appearance after washing), thoughts concerning the quality of the evaluation occurred. When deciding the different smoothness grades of test specimens compared to the replicas, difficulties can occur due to the uneven creased surface. On a test specimen the edges can be more or less creased, compared to the centre of the test specimen. This can cause confusion for the evaluators and error in the measurement might occur.

When conducting the evaluation of the 80 crease resistant resin treated specimens and the untreated specimens, this was one of the hardest factors to look beyond. From this problem a potential solution grew, and when evaluating all the specimens a special plate was created for an easier evaluation of the creasing compared to the replicas. Two black, stiffer papers, similar with the shape and size of the replicas were modified with a hole in the middle, with the size of 20 cm in diameter. These where later tested by covering the test specimen and the one replica that was believed to be the most similar with the crease of the test specimen. This gave a more precise evaluation area of the test specimen and reference area of the replicas.

This development of the smoothness appearance after washing was, however, not used when evaluating the test specimens for this report. If IKEA would be interested in testing and, in the future, use this development of the smoothness appearance evaluation, their own test instruction based on ISO standard SS-EN ISO 6330 with this development, would need to be created.

Figur 9: The AATCC test replicas
6. Discussion

6.1 Method discussion
Several quality tests have been conducted on the crease resistant finished specimens to help in the process of evaluating the different resins scanned in this project. The tests conducted were: smoothness appearance after washing, dimensional change after washing, tensile strength, formaldehyde content and deviation from indicated weight.

When analysing the results received in testing smoothness appearance of the fabric specimens, some factors needed to be taken in consideration. The test was conducted by comparing the fabric specimen to creased replicas rated from 1 – 5, where 1 appeared to be the most creased. The result value is a mean value, calculated out of five values from the same type of resin treated material, which were individually evaluated by three persons. The evaluation was conducted when the fabric specimen and test replicas were lit up by a fluorescent lamp. According to standard ISO 6330, the fabric specimens are supposed to be conditioned for at least 4 hours prior to the evaluation. Due to lack of instruments at the Swedish school of Textiles, this preparation could not be done. Instead, the specimens were kept plain and separate for 12 hours in regular indoor conditions.

The measuring of dimensional change after washing was conducted after one wash. Markings had been made according to standard ISO 3759 on the fabric specimens prior to the wash. When the specimens were dry and had been kept plain and separate for 12 hours, like the testing of smoothness appearance, they were measured with a standardized ruler. Five specimens from each resin treated material were measured and a mean value was then taken, which makes the result more reliable. If one specimen value differed remarkably from the others, this value was taken out of consideration when calculating the mean value, this to ensure an accurate result. Here as well, the conditioning of the specimens could not be done, which possibly affected the result. The specimens were kept plain and separate for 12 hours in regular indoor conditions.

The measuring of tensile strength was conducted at The School of Engineering in Borås. These measurements have to be viewed with some important factors considered. The tensile testing of the test specimens where not done according to IKEA’s test standard and therefore the result of the measurements are not comparable with the demands from IKEA regarding their bed linens tensile strength (Specification: Textiles – general requirements for finished products. IKEA of Sweden). However one can compare the decrease of tensile strength after easy care resin treatment and also compare the specimens to each other.

When measuring the absorbance, caused by the formaldehyde content in the test liquids, the results were critically viewed due to different factors. The biggest concern when analysing the result from the chemicals Permafresh Silver and Quecodure FFL, which according to their technical descriptions should be free from formaldehyde, was that the result showed some absorbance. Most likely, this was caused by the reflection of the small plastic cuvette holding the test liquid.

When measuring the deviation from indicated weight, merely three test pieces from each chemical/fabric combination were weighted. This may have been too few specimens for
creating an accurate measure, and was taken in consideration when analysing the result.

Due to lack of instruments and equipment at The Swedish School of Textiles and The School of Engineering in Borås, the results from the quality testing did not appear as exact as they would need to be for IKEA to be able to rely on them. When looking back at the practical part of this project, the more accurate way of approaching the problem with the quality testing, would have been to execute all laboratory work, concerning the quality testing, at the test laboratory at IKEA in Älmhult. This would have provided us with results comparable with the demands IKEA have for their bed linen regarding different properties that were tested in this project.

Difficulties in form of falling out of the time table was unavoidable due to problems with receiving chemicals from different suppliers. There has been trouble with delayed orders, and misunderstandings between the suppliers and us. Consequently, there was little time for correcting mistakes in the quality testing part of the project. However, through these weeks, much new knowledge has been received, and the practical part in the laboratory has helped to understand and analyse the problem.

6.2 Result analysis

Regarding the results an extensive discussion has been carried out. The results from each resin have been evaluated and analyzed.

First chemical being discussed was Permafresh Silver. This chemical was one of the chemicals described as formaldehyde free. This agreed with the formaldehyde content testing that we conducted which showed extremely low absorbency (see table VI). This received absorbency value might be caused by the reflection of the plastic cuvette holding the test liquid.

When looking at table III the smoothness appearance after washing for this chemical showed one of the lowest results. This might be caused by us lowering the temperature during fixation of the resin chemical, this due to us noticing the fabric appearance turning yellowish when cured at higher temperature. When this temperature decrease was conducted the fabric specimens kept their regular whiteness.

The tensile testing on the cotton fabric impregnated with this chemical showed high obtained strength after crease resistant treatment (see table V). The cotton/lyocell impregnated with Permafresh Silver showed high obtained strength in warp direction, however 45% decrease in weft direction, which might have been caused by us testing quite small samples (10 x 2 cm). This big difference between warp and weft may therefore be an unreliable result.

The second Permafresh resin (Permafresh CSI-2) showed a higher amount of formaldehyde content than Permafresh Silver (table VI). For Permafresh CSI-2 on cotton/lyocell (no. 9) a remark has been done. When evaluating this resin regarding the Dimedone test (table VII) and also looking back at table VI, where the absorbency (As) for Permafresh CSI-2 on a cotton/lyocell fabric (no. 9) is twice as high as for the same resin treated on a cotton fabric (no.2). This has been discussed and the conclusion is that this higher absorbency found in table VI (no. 9) might be caused by some colouring factors. This analyze is supported by the extremely low formaldehyde description given about this chemical from its supplier. (Appendix 4) The resin was described to be meeting Oeko-tex standard, which is maximum 75 ppm formaldehyde. The conclusion of this was then that the formaldehyde content was low and possibly lower than 20 ppm, however, this could not be guaranteed based on our testing, and therefore further formaldehyde content testing is recommended.
This chemical showed a medium result regarding the smoothness appearance after washing for the cotton quality, but low and decreasing after 10 washes for the cotton/lyocell quality (table III). Like Permafresh Silver this might also have been a consequence from lowering the temperature during curing.

Seen in table V, the tensile strength of the cotton/lyocell quality had relatively highly retained strength both in warp and in weft after impregnation and fixation. The cotton quality however showed a bigger loss in both directions.

For the last of the Permafresh resins, looking at table VI, the measured absorbency of Permafresh SWT resin chemical showed high and medium ratings, in comparison with the other chemicals. As seen in table III, Permafresh SWT showed low and medium results in the smoothness appearance after washing. For both qualities a decrease was noticed after the 10 washes that were conducted in accordance with the quality demands from IKEA.

When looking at the tensile strength (table V) the measured values of 105.98 % of retained strength is viewed with thought of potential error in measurement. This value is, though, kept due to the non-exciting information about the impact this particular resin has on the fabric strength.

The chemical Quecodur FFL was another chemical described as formaldehyde free when studying the technical description obtained from the supplier. The formaldehyde testing we did on the fabrics impregnated with this resin indicated that this in fact was the case (table VI). As well as for Permafresh Silver, the absorbance value for Quecodur FFL, showing in table VI, can also be caused by reflection of the plastic cuvette holding the test liquid. However looking at table III, the smoothness appearance after washing for this chemical was medium after the first wash and low after the ten washes. This decrease indicates the resin to not being suitable for IKEA’s bed linen.

The chemical Quecodur SLF was one of the resins that showed best result in the smoothness appearance after wash number one (table III) however a small (0,5) decrease of smoothness appearance after ten washes was noticed. Even though the degree of smoothness should be obtained after the ten washes, we consider this chemical a potential resin for IKEA to further evaluate. This decision was made based on the circumstances of the smoothness evaluation. Due to us not having the exact right conditions and equipment for doing the evaluation according to ISO standard SS-EN ISO 6330 (smoothness appearance after washing) we could view the decrease as a potential error measuring. The formaldehyde content of this chemical was medium compared to the other chemicals analyzed. The tensile testing of these chemical impregnated on cotton and cotton/lyocell showed various results. For cotton, the retained strength was rather high, and for the cotton/lyocell, the retained strength was high in warp direction, but lower in weft direction.

Texfin CR from Texchem was a combined resin, catalyst and softener, and seen in table VI, this resulted in the highest amount of formaldehyde, for both qualities impregnated with this resin. This also entailed the best result in smoothness appearance (table III). Which indicated the necessity of the formaldehyde in the resin. However, as seen in table V, the higher amount of formaldehyde also resulted in a high decrease of retained strength, in both warp direction and weft direction, when testing the tensile strength. When analysing the smoothness appearance, this would be a resin to recommend to IKEA, however, further analysis is required, due to the result in formaldehyde content and tensile strength.
Resin PLF was also described by the supplier as a combined, or pre-catalysed resin, and therefore resulted in the fabric qualities containing a high amount of formaldehyde (table VI). The resin was described as containing ultra-low amounts of formaldehyde, which was noticed when comparing it to Texfin CR. In table III, Resin PLF showed good properties in smoothness appearance, which was a result of it containing higher amount of formaldehyde, like Texfin CR. It was also similar to Texfin CR in table V, which showed the retained strength after easy care resin treatment. When analysing the smoothness appearance of these two very similar resins, this would be a resin to recommend to IKEA, however, further analysis would be required, due to the result in formaldehyde content and tensile strength.

Worth observing was the dimensional change after washing for all the resins and different qualities. For all these 14 combinations, the requirements of not exceeding 2 % stretch, and 4 % shrinkage were accomplished. (IKEA specification: Textiles – general requirements for finished products, Spec no. IOS-PRG-0023)

The development of the smoothness appearance after washing evaluation (5.6 Development of the evaluation of smoothness appearance after washing), in form of the modified black papers, was considered and viewed in the early development stage. The addition, to the so often tricky evaluation, was only tested two separate times, on five test specimens each time. Three persons tested the developed method and experienced it as an improvement for the evaluation step in the method of smoothness appearance after washing.
7. Conclusion and recommendations

In this chapter, the resins recommended for IKEA will be presented. As described in the discussion (6.1 Method discussion), the conclusion was taken to recommend resins with promising properties, however, that need further quality testing and evaluation.

Due to the inability of completing all quality testing, and due to unreliable results, we have understood that we will be able to recommend resins to IKEA only with the exception that further evaluate must be conducted. We will therefore recommend the resins with best properties in comparison to each other. With this recommendation we will also urge IKEA to continue a small scale of quality testing on the fabrics impregnated with these resins.

The recommended resins for the cotton weave are:
- Permafresh CSI-2
- Texfin CR
- Resin PLF

All three resins showed good smoothness appearance after washing, and a durability of the property after ten washes, though Permafresh CSI-2 was slightly lower rated in the evaluation (table III). Permafresh CSI-2 showed a slight higher obtained strength after easy care resin treatment compared to Texfin CR and Resin PLF. However, in total, they all showed a big loss in tensile strength (table V). The tree resins varied in amount of formaldehyde content (table VI). They were described, by their suppliers, as containing low amount of formaldehyde, and for this reason together with the amount of lost tensile strength, we urge IKEA to continue with the quality testing.

The recommended resins for the cotton/lyocell weave are:
- Quecodur SLF
- Texfin CR
- Resin PLF

Like the resins recommended for the cotton weave, these three resins recommended for the cotton/lyocell weave all showed good smoothness appearance after washing (table III). Regarding the obtained strength after easy care resin treatment (table V) and the amount of formaldehyde content (table VI), all three resins showed undesired results, which is why we also in this case, urge IKEA to continue with the quality testing.
8. Suggestions for further studies

• Continuing with the quality testing that was conducted in this study would help to develop more reliable results.

• Implementing a study where different amount of the same resin is impregnated on the fabrics, to see which amount (or recipe) fits IKEA’s demands.

• Implementing a study on other material from IKEA’s bed linen department would help in choosing the most suitable resin for IKEA.

• Conducting an economical research would benefit when comparing and choosing the most relevant resin for IKEA.
9. References

Literature:


Articles:


10. Özcelik Kayseri, Gonca, Bozdogan, Faruk (2010), "Performance properties of regenerated cellulose fibers", *EGE University Textile and Apparel Research & Application Center, Volume 20, Issue 3*


Internet:

15. IKEA, *Om IKEA, Vår Affärstid* –
http://www.ikea.com/ms/sv_SE/about_ikea/the_ikea_way/our_business_idea/index.html?icid=se%3Eic%3Efooter%3Eom_var-affarside
Fetched: 2011-04-05

16. Miljö & socialt ansvar –
http://www.ikea.com/se/sv/store/malmo/miljosocialt
Fetched: 2011-04-26

17. IKEA, *Om IKEA, Vårt ansvar* –
http://www.ikea.com/ms/sv_SE/about_ikea/our_responsibility/index.html
Fetched: 2011-04-26

18. IKEA, *Om IKEA, Tidsaxel* –
http://www.ikea.com/ms/sv_SE/about_ikea/the_ikea_way/history/index.html
Fetched: 2011-05-02

19. IKEA, *Om IKEA, från 1940-talet till 1950-talet* –
http://www.ikea.com/ms/sv_SE/about_ikea/the_ikea_way/history/1940_1950.html
Fetched: 2011-05-02

20. IKEA, *Om IKEA, Fakta & siffror* –
http://www.ikea.com/ms/sv_SE/about_ikea/facts_and_figures/index.html?icid=se%3Eic%3Efooter%3Eom_fakta-siffror
Fetched: 2011-05-02

Fetched: 2011-05-02

22. IKEA, *The IKEA Organisation* –
Fetched: 2011-05-02

23. Textil, *Mattor sovrumstextilier* -
http://www.ikea.com/se/sv/catalog/categories/departments/Textiles/?icid=se%3Eic%3Eheader%3Ettextil
Fetched: 2011-05-02

24. Sängkläder, *Påslakan & Lakan, IKEA* -
http://www.ikea.com/se/sv/catalog/categories/departments/bedroom/10651/
Fetched: 2011-04-13
25. Fixapret –
http://www2.basf.us/pc_textiles/bctexchemfixapret.html
Fetched: 2011-04-13

26. Formaldehyd, Kemi –
Fetched: 2011-05-02

Documents:

27. United States Government Accountability Office (GAO), August 2010, ”Formaldehyde in textiles”

28. Gustafsson, Barbro (1997), Kemikalier i textilier - redovisning av ett regeringsuppdrag, Kemikaliecinspektionen

Oral references:

29. Marius Lehadus and Anna Palmberg, IoS, Älmhult, Sweden

30. Claes Brodell, Diazo, Sandared, Sweden

31. Wayne Aaron, Texchem, London, UK

32. Sandrine Garner and Johnny Martin, Omnova Solutions, USA

33. Carsten Jensen, BASF, Copenhagen, Denmark

34. Graham Smith, technician, Clariant, Copenhagen, Denmark

Appendix

35. OMNOVA Solutions –
http://www.omnova.com/
Fetched: 2011-04-12

36. OMNOVA Textile Chemical Applications, Technology and Service -
Fetched: 2011-04-12

37. Textile Chemicals, Manufacturer & Supplier, Texchem Ltd. -
http://www.texchem.co.uk/default.html
Fetched: 2011-04-12

38. Texchem - About Us –
http://www.texchem.co.uk/about-us.html
Fetched: 2011-04-12
10. Appendices

Appendix 1 – Company facts

**Omnova Solutions Inc.**
This supplier is from origin USA and their head quarter is located in Fairlawn, Ohio. In 2010 the company merged with another big company, ELIKOKEM. This combined the world’s two leading technology innovators into one big global specialty chemical provider. [35] Today they have 2300 people in their staff in USA, Europe and Asia. Their two businesses are performing chemicals and decorative products. The first product group is where you find their large offering of chemicals for carpets, in-mold coatings, paper, textiles and specialty. The textile specialty office is located in Chester, South Carolina, USA. They have a five-decade experience from the textile industry as a chemical supplier. They were pioneers in durable-press treatment and they have had a long, committed and innovative development of wrinkle-free finishing that has resulted in a wide range of wrinkle-free resins. [36]

**Texchem UK Ltd.**
This supplier is located in Lancashire, England. This is also the location where they started the company in 1987. They are one of the world’s leaders in textile chemicals and they provide chemicals for fabric preparation, dyeing and finishing, such as; water repellent chemicals, flame retardant chemicals and easy-care chemicals. The textile chemical products is the main product range that Texchem is offering, but this knowledge and developing of these chemicals has resulted in expansion to other market segments, such as; tissue, wet wipes and cleaning industries. [37, 38]

**Clariant**
This supplier is origin from Basel, Germany. They started 1995 as a spin-off from the company Sandoz, which in turn established 1886 in Basel. [39] The head quarter is located in Muttenz, near Basel, Germany. Clariant has from the start, in 1995, expanded significantly. In 1997 they incorporated the speciality chemicals business Hoechst from Germany. They also acquired BTP plc, UK (2000), Siba’s Masterbatches division (2006) and the leading U.S. colorant suppliers Rite Systems and Ricon Colors (2008). They have offices all around the world and they also have an office in Mölndal, Sweden. They operate worldwide and are represented in over 100 countries and have approximately 16 200 employees. [40] Their product offering is wide and they are divided into 10 business units; additives, detergents and intermediates, emulsions, industrial and consumer specialities, leather services, master batches, oil and mining services, paper specialties, pigments, and textile chemicals. [41]
**BASF**

This supplier is the world’s leading chemical company and is working globally all over the world. They have 109,000 employees and operate in almost every country in the world. [42] It is a German chemistry company that was established in 1865 and the headquarter is located in Ludwigshafen, Germany. [43] They have offices all around the world, including in Sweden where the head office is located in Gothenburg. [44] BASF’s different market segments can be divided into: chemicals, plastics, performance products, functional solutions, agricultural solutions and oil, and gas. In the product group performance product you find performing chemicals and here the easy care resins is represented. BASF has 100 years of experience of working with textile chemicals. This is the current supplier that IKEA uses today to their easy care finishing of bed sets. Today they uses a resin chemical named Fixapret NF.

**Diazo**

This supplier is situated in Sweden, in Sandared and has been a company since 1972. [45] They work with suppliers all around the world and this has resulted in a wide range of products and also a great deal of knowledge about the different chemical industries that they work with. [46] Diazo’s goal is to provide the industry with a better option, technically, environmentally and economically. [47] The different industries Diazo work with are; textiles, food, hygiene and non-woven, paper and plastic, and rubber. [48]
Appendix 2 – 11 – Technical descriptions

Appendix 2 – Technical description BASF; Fixapret ECO

### Fixapret® ECO

Considerable for extremely low-formaldehyde easy-care finishing of textiles composed of synthetic fibers and their blends with synthetic fibers

#### Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product specification</td>
<td>Technical for fast characteristics are given in the product specification.</td>
</tr>
<tr>
<td>Stability</td>
<td>Miscellaneous with cool water in all processes.</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Fixapret ECO is compatible with most finishing agents. When several products are to be viewed together, the compatibility should be tested. Fixapret ECO is not compatible with Perylene® E. and Harsa® H20.</td>
</tr>
</tbody>
</table>

#### Application

- Easy to store finishing and contact finishes composed of synthetic fibers and their blends with synthetic fibers
- Very good accessories effects
- Conforms to One-Def Standard 100, Product Class II
- The finishing effects are fast to washing and dry cleaning
- Soft handle
- Very good stability to hydrolysis

#### Application rates

<table>
<thead>
<tr>
<th>Application rate</th>
<th>Amount per kg of Fixapret ECO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2%</td>
<td>0.1% of Fixapret ECO</td>
</tr>
<tr>
<td>0.3%</td>
<td>0.3% of Fixapret ECO</td>
</tr>
<tr>
<td>0.4%</td>
<td>0.4% of Fixapret ECO</td>
</tr>
</tbody>
</table>

#### Application conditions

Fixapret ECO’s applicable padding at room temperature. The liquor pickup is 80–85%, according to fabric type.

The proof for ease to use finishing liquor should be approx. 4–0–0.5.

Drying is performed at 150–155 °C.

The following conditions (g/l) are recommended for curing Fixapret ECO by the conventional drying processes:

- **Vegetable (Bottle)**: boiling and 0.15 g/l Fixapret ECO (drying at 170 °C, 0 at 100 °C)
- **Blade (Dip)**: boiling and 0.1 g/l Fixapret ECO (drying at 170 °C, 0 at 100 °C)
- **Blade (Steam)**: boiling and 0.1 g/l Fixapret ECO (drying at 170 °C, 0 at 100 °C)
- **Kraft (Steam)**: boiling and 0.1 g/l Fixapret ECO (drying at 170 °C, 0 at 100 °C)

### Safety

When using this product, the information and advice given in our Safety Data Sheet should be observed. The information should also be given to the personnel responsible for handling the product.

### Note

The data contained in this publication are based on our current knowledge and experience. In no case is any warranty or guarantee implied. Information given is neither an offer of sale nor a recommendation to use this material in a particular manner. The user of this information assumes all responsibility for his own safety and the safety of third parties. The information given is based on the experience and practice that are known to BASF. It is to be used at the user’s own discretion and risk. BASF shall assume no liability whatsoever for the resulting damage or loss to persons or property. Claims for compensation, with the exceptions made for non-economic damages, are excluded. No modifications or additions to this document are allowed without prior written consent of BASF. BASE 312 Performance Chemicals for Textiles D-50354 Cologne, Germany www.base.com/textile
Appendix 3 – Technical description, BASF Fixapret NF
Appendix 4 – Technical description, Omnova CSI – 2

<table>
<thead>
<tr>
<th>PHYSICAL PROPERTIES</th>
<th>TYPICAL PROPERTIES</th>
<th>CHEMICAL/PHYSICAL PROPERTIES</th>
<th>APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact number</td>
<td>Permafresh® CSI-2</td>
<td>Physical properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td>Fluidity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Omnova®</td>
<td>Solubility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI-2</td>
<td>Color</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI-2</td>
<td>Types of SiO bonds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI-2</td>
<td>Stability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI-2</td>
<td>Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI-2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PERMAFRESH® CSI-2 PROPERTIES

- Concentrated pre-neutral soapless wash containing less than 0.05% formalddehyde.

PERMAFRESH® CSI-2 ADVANTAGE

- Non-flame reactive finishing
- Provides low flammability levels on treated fabric
- Excellent dirt soil resistance
- Excellent sheen control
- Excellent film smoothness
- Virtually no yellowing

PERMAFRESH® CSI-2 HANDLING

- This product is available in bulk, totes, 55-gallon drums or plastic drums.
- Recommended storage temperature is 70°F (21°C). When stored as recommended, the minimum shelf life of the product is 12 months.

As with all chemicals, please read the material safety data sheet (MSDS) prior to use. An MSDS for each Omnova product is provided with the shipment and periodically thereafter. An MSDS also may be obtained at any time by contacting your Customer Service Representative or by calling (800) 265-1034.
Appendix 5 – Technical description, Omnova Permafresh Silver
Appendix 6 – Technical description, Clariant Arkofix ELF

1. Properties

1.1 Appearance
Clear liquid, non-corrosive, non-hazardous, non-flammable.

1.2 Chemical character
- Formula: C8H14O2
- Molecular weight: 130.20
- Boiling point: 170°C
- Flash point: 35°C
- Density: 0.89 g/cm³

1.3 Solubility
- Soluble in water
- Soluble in alcohol
- Soluble in most organic solvents

1.4 Storage stability
Stable at room temperature for at least 6 months.

1.5 Toxicity
Non-toxic, non-carcinogenic, non-mutagenic, non-teratogenic.

1.6 Environmental data
- Biodegradable
- Harmless to aquatic life
- Safe for soil

2. Applications

2.1 Use in traditional Pad-Dry-Cure process
The recommended use is for hot pad printing processes. The most suitable process temperature is 150-170°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

3. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

4. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

5. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

6. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

7. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

8. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

9. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

10. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

11. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

12. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

13. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

14. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

15. Use in continuous heat-setting processes
Arkofix ELF is suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.

16. Use in continuous heat-setting processes
Arkofix ELF is also suitable for use in continuous heat-setting processes. The process temperature should be 170-190°C. The printed fabric should be cured for 60-90 seconds to achieve optimal results.
Appendix 7 – Technical description, Clariant Arkofix NZF
Appendix 8 – Technical description, Texchem; Texfin CR

### Technical Data Sheet

**Texfin CR**

Texfin CR is a conditioned easy-to-melt flake, suitable for the finishing of cotton, polyester, viscose, etc. in a continuous process. It can be used in various finishing processes on the textile industry. It has been developed to improve the performance of the finishing process and to provide a high-quality finish with excellent properties.

#### Notes

- **Application**: Semi-liquid or liquid emulsion
- **Compatibility**: Suitable for a wide range of cotton, polyester, viscose, and other cellulose-based fabrics
- **Preparation**: Use at 10-20°C (50-68°F) for best results
- **Stability**: Stable for at least 12 months under normal conditions
- **Packaging**: 25 kg drums

#### Technical Specifications

- **Appearance**: Semi-liquid or liquid emulsion
- **Solvent Content**: 5-10% v/v
- **pH**: 7-8
- **Density**: 1000-1100 kg/m³
- **Viscosity**: 500-1000 mPa·s
- **Saponification Value**: 200-250
- **Free Fat**: ≤ 0.5%

#### Advantages

- **Stability**: Excellent stability at high temperatures
- **Dyeability**: Excellent dyeability
- **Softness**: Excellent softness
- **Shrinkage Resistance**: Excellent shrinkage resistance
- **Crease Resistance**: Excellent crease resistance

#### Usage Instructions

1. **Application**: Apply the solution to the fabric before the finishing process.
2. **Drying**: Dry the fabric at 120-140°C (250-280°F) for 30-60 seconds.
3. **Curing**: Cure the fabric at 160-180°C (320-350°F) for 60-120 seconds.

#### Notes on Application

- **Temperature**: Use at 10-20°C (50-68°F) for best results.
- **Storage**: Store in a cool, dry place.
- **Handling**: Avoid contact with eyes and skin.

---

**Texfin CR Solution**

- **Fabric Type**: Cotton, Viscose, Polyester
- **Dyeing**: Use a solution containing 1% of Texfin CR
- **Curing**: Cure the fabric at 160-180°C (320-350°F) for 60-120 seconds.

---

**Advantages of Texfin CR**

- **Uniformity**: Excellent uniformity
- **Dyeability**: Excellent dyeability
- **Softness**: Excellent softness
- **Shrinkage Resistance**: Excellent shrinkage resistance
- **Crease Resistance**: Excellent crease resistance
- **Stability**: Excellent stability at high temperatures

---

**Technical Notes**

- **Application**: Use at 10-20°C (50-68°F) for best results.
- **Storage**: Store in a cool, dry place.
- **Handling**: Avoid contact with eyes and skin.

---

**Diagram**

![Texfin CR Solution](image-url)
Appendix 9 – Technical description, Texchem; Resin PLF

Technical Data Sheet

Resin PLF

Resin PLF is a very low formaldehyde pre-catalysed resin for durable crease resistant and shrink resistant finishing of cellulose fabrics and their blends with synthetic fibres. For optimum results it is important that the substrate to be finished is free from alkali residues. The fabric must be neutral before finishing as any residual alkali will impair crosslinking which in turn will reduce the crease recovery and dimensional stability. It can also lead to excessive formaldehyde values on the finished goods. Resin PLF shows no chlorine retention on 100% Cotton.

Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form (at 20°C)</td>
<td>Pale yellow liquid</td>
</tr>
<tr>
<td>Chemical Nature</td>
<td>Modified N-Methylol Dihydroxy Ethylene Urea</td>
</tr>
<tr>
<td>pH 1% Solution</td>
<td>Approx 4.00</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.18 (at 20°C)</td>
</tr>
<tr>
<td>Odour</td>
<td>None</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Product is compatible with the majority of other auxiliaries, however ‘in-house’ checks are strongly advised prior to use</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>Product is stable for at least 6 months if stored in recommended conditions</td>
</tr>
<tr>
<td>Thermal Stability</td>
<td>Product is stable up to 40°C</td>
</tr>
<tr>
<td></td>
<td>Product is stable to 0°C</td>
</tr>
<tr>
<td>Storage conditions</td>
<td>Product should be stored between 10 and 30°C</td>
</tr>
</tbody>
</table>

Application

Generally 40 - 120 g/L by pad application depending upon cellulosic content of substrate.

Resin PLF can be applied through a Baker or Stenter providing suitable cure conditions are identified, please contact Texchem for recommendations.

Typical finishing recipe for 100% cotton or polycotton blends -

40 - 80 g/L Resin PLF
10 – 20 g/L Silicone softener

Pad dry and Cure at 160°C for 2 minutes.
Appendix 10 – Technical description, Diazo; Quecodur FFL Plus

QUECODUR FFL PLUS
TECHNICAL DATA
A integrated resin and catalyst system for formaldehyde-free, easy-care finishing of fabrics at low curing temperatures

CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consitution</td>
<td>Formaldehyde free imidolaceton derivative with integrated catalyst system</td>
</tr>
<tr>
<td>Appearance</td>
<td>Colourless to slightly yellowish-clear low viscosity liquid</td>
</tr>
<tr>
<td>pH value</td>
<td>1.0-2.5</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>1.1-1.2 g/cm³</td>
</tr>
<tr>
<td>Solubility</td>
<td>Dilutable with cold water in any ratio</td>
</tr>
<tr>
<td>Storage</td>
<td>Can be stored for at least 6 months in closed containers at ambient temperatures</td>
</tr>
</tbody>
</table>

PRODUCT BENEFITS

- Used for the formaldehyde free, easy-care finishing of woven and knitted fabrics made from cellulosic fibres and their blends with synthetic fibres
- Can be cured at a temperature of 150°C applied by a dry overspraying process on fabric, and by spray free finishing on garments
- Free of formaldehyde
- Does not require an additional catalyst
- Does not normally cause the typical “garlic odour” associated with many formaldehyde free finishes when correctly applied
- Gives durable wash and wear effects without chlorine retention
- Suitable for white and dyed fabrics giving a comfortable handle
- Normally compatible with auxiliaries used for resin finishing

SPECIAL ADVICE

- QUECODUR FFL PLUS has been developed to cure at low temperatures, higher temperatures can lead to the risk of fabric colour
- On prolonged storage at lower temperatures partial crystallisation may occur, but on warming, deposit re-dissolves without affecting the efficiency in performance
- For optimum results the resin should be applied at pH 4.5
- Only stable optical brightening agents should be used, to guarantee satisfactory whitening.

QUECODUR FFL PLUS
TECHNICAL DATA
A integrated resin and catalyst system for formaldehyde-free, easy-care finishing of fabrics at low curing temperatures

CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consitution</td>
<td>Formaldehyde free imidolaceton derivative with integrated catalyst system</td>
</tr>
<tr>
<td>Appearance</td>
<td>Colourless to slightly yellowish-clear low viscosity liquid</td>
</tr>
<tr>
<td>pH value</td>
<td>1.0-2.5</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>1.1-1.2 g/cm³</td>
</tr>
<tr>
<td>Solubility</td>
<td>Dilutable with cold water in any ratio</td>
</tr>
<tr>
<td>Storage</td>
<td>Can be stored for at least 6 months in closed containers at ambient temperatures</td>
</tr>
</tbody>
</table>

PRODUCT BENEFITS

- Used for the formaldehyde free, easy-care finishing of woven and knitted fabrics made from cellulosic fibres and their blends with synthetic fibres
- Can be cured at a temperature of 150°C applied by a dry overspraying process on fabric, and by spray free finishing on garments
- Free of formaldehyde
- Does not require an additional catalyst
- Does not normally cause the typical “garlic odour” associated with many formaldehyde free finishes when correctly applied
- Gives durable wash and wear effects without chlorine retention
- Suitable for white and dyed fabrics giving a comfortable handle
- Normally compatible with auxiliaries used for resin finishing

SPECIAL ADVICE

- QUECODUR FFL PLUS has been developed to cure at low temperatures, higher temperatures can lead to the risk of fabric colour
- On prolonged storage at lower temperatures partial crystallisation may occur, but on warming, deposit re-dissolves without affecting the efficiency in performance
- For optimum results the resin should be applied at pH 4.5
- Only stable optical brightening agents should be used, to guarantee satisfactory whitening.
Appendix 11 – Technical description, Diazo SLF Plus

QUECODUR SLF PLUS

TECHNICAL DATA

A reaction resin with an integrated catalyst system for easy-care finishes giving low formaldehyde levels.

CHARACTERISTICS

- Constitution: Based on a modified difunctional ethoxylated triethylene amin with a catalyst incorporated into the system
- Appearance: Clear, colorless to pale yellow liquid
- pH Value: 2.0 - 2.6
- Stability: 
  - 1.29 = 0.88 g/cm³
  - Available with anti-wash in any ratio
- Storage: Can be stored for at least 12 months in closed containers at ambient temperatures.

PRODUCT BENEFITS

- Ideal for the near finishing of woven and knitted cellulose fibres and their blends
- Applied by normal dry crosslinking methods on fabric or used for water-free finishing of garments
- Gives low formaldehyde levels on the treated fabric, meeting Dye Standards
- Single stage wool system, requiring no additional catalyst
- Gives wash and wear effects durable to washing up to the boil
- Gives chlorine resistant finishing
- Suitable for use with wet or dry cleaning agents
- Minimises shrinkage losses
- Minimises shade alterations and the tendency to yellow
- Gives excellent crease recovery and shrinkage control
- Can be used with fluorocarbon-based water repellents

SPECIAL ADVICE

- Must not be used with paraffin waxes or water repellents
- For bulk storage plastic or fibre glass containers are recommended
- Rinse the fabric in well-prepared, washed-out soda and use any remaining detergent in the washing process.
- Only vital optical brightening agents should be used, to guarantee satisfactory...

In order to achieve optimum curing the fabric should be fully absorbent and free of residual oils from the pre-treatment stage. This then ensures low formaldehyde values with good technical properties. The amount of QUECODUR SLF PLUS should be added to the 20% water at 60°C and used up to its final volume.

APPLICATION:

PAD APPLICATION – DRY CROSSLINKING

<table>
<thead>
<tr>
<th>Wash &amp; Wear on 100% Cotton</th>
<th>Low Shrinkage Finish 100% Viscose</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUECODUR SLF PLUS</td>
<td>10-15g/l</td>
</tr>
<tr>
<td>Formol 8% Conc.</td>
<td>14-19g/l</td>
</tr>
<tr>
<td>Formal SFB</td>
<td>8-12g/l</td>
</tr>
<tr>
<td>Acid. Acid.</td>
<td>1.5-2.5%</td>
</tr>
<tr>
<td>Pick up</td>
<td>70-90%</td>
</tr>
</tbody>
</table>

Double Pass Process Drying: 110-130°C
Curing: 145-155°C for 4-3 minutes
Single Pass Process Rapid Curing: 160-170°C for 30-45 seconds

WRINKLE FREE APPLICATION

<table>
<thead>
<tr>
<th>Garment</th>
<th>100% Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUECODUR SLF PLUS</td>
<td>10-15g/l</td>
</tr>
<tr>
<td>Formol 8% Conc.</td>
<td>10-15g/l</td>
</tr>
<tr>
<td>Formal SFB</td>
<td>8-12g/l</td>
</tr>
<tr>
<td>Acid. Acid.</td>
<td>1.5-2.5%</td>
</tr>
<tr>
<td>Pick up</td>
<td>70-90%</td>
</tr>
</tbody>
</table>

The garments are treated either in an industrial washing machine at 90°C using a liquor ratio between 1:8 and 1:10 for 15-30 minutes followed by hydro-pressing or for spray application. After tumble drying and pressing, the garments are cured at 150-155°C for 8-12 minutes in an oven.

PACKAGING:

140kg Drum
120kg Container

The information contained in this leaflet is intended to be of assistance to users but is subject to change. Variations occur in application and usage are advised to conduct their own tests. Suggestions for use neither give nor imply any freedom from patent infringement.
Appendix 12 – Interview with Marius Lehadus and Anna Palmberg from IoS

2011-04-07

What suppliers are you working with today, providing you with easy care chemicals?

What resin are you using?

Where is the easy care finishing situated?

How big part of IKEA’s assortment is textiles?

How big is bed linen of the whole textiles assortment?
## Appendix 13 – Easy care finish scheme

Table II: Easy care finish scheme, based on Appendix 2-11

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Chemical</th>
<th>Pick-up (%)</th>
<th>Cure temperature (°C)</th>
<th>Curing time (min)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>1</td>
<td>Permafresh Silver</td>
<td>79</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Permafresh CSI-2</td>
<td>77</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Permafresh SWT</td>
<td>77</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Quecodur FFL</td>
<td>80</td>
<td>130</td>
<td>3</td>
<td>Combined drying and curing</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Quecodur SLF</td>
<td>75</td>
<td>150</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Texfin CR</td>
<td>79</td>
<td>150</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Resin PLF</td>
<td>77</td>
<td>160</td>
<td>2</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td>Cotton/lyocell</td>
<td>8</td>
<td>Permafresh Silver</td>
<td>73</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Permafresh CSI-2</td>
<td>73</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Permafresh SWT</td>
<td>75</td>
<td>150*</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Quecodur FFL</td>
<td>80</td>
<td>130</td>
<td>2</td>
<td>Combined drying and curing</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Quecodur SLF</td>
<td>75</td>
<td>150</td>
<td>3</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Texfin CR</td>
<td>78</td>
<td>150</td>
<td>2</td>
<td>Dried in stenter before curing</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Resin PLF</td>
<td>77</td>
<td>160</td>
<td>2</td>
<td>Dried in stenter before curing</td>
</tr>
</tbody>
</table>

* The degrees for the Permafresh Resins was lowered from 164 °C to 150 °C due to tendency of yellowness of the fabric.
Appendix 14 – 20 – Process work cards; 100 % cotton
Appendix 14 – Omnova; Permafresh CSI-2

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impergnation with Pad Batch and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatment: Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering

CHEMICAL SUPPLIER:
Company OMNOVA

Trade name: Permafresh CSI-2

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh CSI-2</td>
<td>Resin</td>
<td>80 g/l</td>
</tr>
<tr>
<td>Sequawet 16</td>
<td>Surfactant for wetting</td>
<td>2 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

**Pad Batch settings:** 70 – 80 %, we used 77 %

**Fixation with stenter (settings):** Dried, then cured at 150 °C. The recipe said 164 °C, this showed signs of “yellowness”. This will be taken in consideration when evaluating the fabric.

**Comments:** Mykon HLC (PE emulsion for tear strength) was not delivered. This will be taken in consideration when testing the fabric. Mykosil LS-25 10g/l was added for potential better tear strength.
Appendix 15 – Omnova; Permafresh Silver

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatment: Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering

| CHEMICAL SUPPLIER:       |                          |
| Company                  | OMNOVA                  |

Trade name: Permafresh Silver

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh Silver</td>
<td>Resin</td>
<td>80 g/l</td>
</tr>
<tr>
<td>Catalyst 531</td>
<td>Catalyst</td>
<td>20 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1 l

Pad Batch settings: 70 – 80 %, we used 79 %
Fixation with stenter (settings): Dried, then cured at 150 °C. The recipe said cure in 164 °C, this showed signs of “yellowness”. This will be in consideration when evaluating the fabric.
Comments: Mykon 122 is replaced with Mykosil LS-25. This will be taken in consideration when testing the fabric. Sulfanole 634 was not delivered, this will be taken in consideration when evaluating.
Appendix 16 – Omnova; Permafresh SWT

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatment:
Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering

Chemical Supplier:
Company OMNOVA

Trade name:
Permafresh SWT

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh SWT</td>
<td>Resin</td>
<td>80 g/l</td>
</tr>
<tr>
<td>Sequawet 16</td>
<td>Surfactant for wetting</td>
<td>2 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1 l

**Pad Batch settings:** 70 – 80 %, we used 77 %

**Fixation with stenter (settings):** Dried, then cured at 150 °C. The recipe said 164 °C, this showed signs of “yellowness”. This will be taken in consideration when evaluating the fabric.

**Comments:** Mykon HLC (PE emulsion for tear strength) was not delivered. This will be taken in consideration when testing the fabric. Mykosil LS-25 10g/l was added for potential better tear strength.
Appendix 17 – Texchem; Texfin CR

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machine type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Gäspa</td>
<td>Wrinkling finishing; Impregnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatment:

<table>
<thead>
<tr>
<th>CHEMICAL SUPPLIER:</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texchem</td>
<td></td>
</tr>
</tbody>
</table>

Trade name:

<table>
<thead>
<tr>
<th>Trade name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texfin CR</td>
</tr>
</tbody>
</table>

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texfin CR</td>
<td>Resin</td>
<td>200 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

**Pad Batch settings**: Pad 70 - 80 % pick-up, we used 79 %

**Fixation with stenter (settings)**: Pad dry at 130°C and cure for 120 seconds at 150°C.
Appendix 18 – Texchem; Resin PLF

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machine type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Gäspa</td>
<td>Wrinkling finishing; Impregnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatment: 
Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering

CHEMICAL SUPPLIER: Texchem

Trade name: Resin PLF

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin PLF</td>
<td>Resin</td>
<td>120 g/l</td>
</tr>
<tr>
<td>Texsoft PFS New</td>
<td>Softener</td>
<td>20 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

**Pad Batch settings:** Pad 70 - 80 % pick-up, we used 77 %

**Fixation with stenter (settings):** Pad dry at 130°C and cure for 120 seconds at 160°C.
Appendix 19 – Diazo; Quecodur FFL Plus

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machine type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Gäspa</td>
<td>Wrinkling finishing; Impregnation with Pad Batch and setting with stenter</td>
</tr>
<tr>
<td>Previous treatment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| CHEMICAL SUPPLIER:        | Trade name:    |                                                                                          |
| Company                   | Quecodur FFL Plus |                                                                                          |

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quecodur FFL Plus</td>
<td>Resin</td>
<td>120 g/l</td>
</tr>
<tr>
<td>Finistrol ESJ conc</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1 l

Pad Batch settings: Pad at 80 % pick-up

Fixation with stenter (settings): Combined dry and curing in one stage at 130 °C for approximately 120 seconds.

Comments: The recipe says 60 seconds, but is not enough. This will be taken in consideration when evaluating the fabric.
Appendix 20 – Diazo; Quecodur SLF Plus

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 100 %</td>
<td>Gäspa</td>
<td>Wrinkling finishing; Impergenation with Pad Batch and setting with stenter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHEMICAL SUPPLIER: Company Diazo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trade name: Quecodur SLF Plus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Previous treatment: Singeing-desizing-washing-cold bleaching-mercerizing-washing-stentering</td>
</tr>
</tbody>
</table>

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quecodur SLF Plus</td>
<td>Resin</td>
<td>60 g/l</td>
</tr>
<tr>
<td>Finistrol ESJ conc</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Finistrol SFB</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Acetic acid</td>
<td></td>
<td>1 ml/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

**Pad Batch settings**: 70 – 80 %, we used 75 %

**Fixation with stenter (settings)**: Drying in 130°C, then cured at 150 °C for 3 minutes.
Appendix 21–27 – Process work cards; 50/50 % cotton/lyocell
Appendix 21 – Omnova; Permafresh CSI-2

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatments:

- Singeing-cold bleaching-washing-alkaline treatment-washing-stentering

CHEMICAL SUPPLIER:

Company OMNOVA

Trade name:

Permafresh CSI-2

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh CSI-2</td>
<td>Resin</td>
<td>100 g/l</td>
</tr>
<tr>
<td>Sequawet 16</td>
<td>Surfactant for wetting</td>
<td>2 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

Pad Batch settings: 70 – 80 %, we used 73 %
Fixation with stenter (settings): Dried, then cured at 150 ºC. The recipe said 164 ºC, this showed signs of “yellowness”. This will be taken in consideration when evaluating the fabric.
Comments: Mykon HLC (PE emulsion for tear strength) was not delivered. This will be taken in consideration when testing the fabric. Mykosil LS-25 10g/l was added for potential better tear strength.
Appendix 22 – Omnova; Permafresh Silver

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatments
- Singeing-cold bleaching-washing-alkaline treatment-washing-stentering

Chemical Supplier:
- Company: OMNOVA
- Trade name: Permafresh Silver

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh Silver</td>
<td>Resin</td>
<td>80 g/l</td>
</tr>
<tr>
<td>Catalyst 513</td>
<td>Catalyst</td>
<td>20 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

Pad Batch settings: 70 – 80 %, we used 73 %
Fixation with stenter (settings): Dried, then cured at 150 °C. The recipe said cure in 164 °C, this showed signs of "yellowness". This will be in consideration when evaluating the fabric.
Comments: Mykon 122 is replaced with Mykosil LS-25. This will be taken in consideration when testing the fabric. Sulfanole 634 was not delivered, this will be taken in consideration when evaluating.
Appendix 23 – Omnova; Permafresh SWT

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous treatments</th>
<th>CHEMICAL SUPPLIER: Company</th>
<th>Trade name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing-cold bleaching-washing-alkaline treatment-washing-stentering</td>
<td>OMNOVA</td>
<td>Permafresh SWT</td>
</tr>
</tbody>
</table>

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafresh SWT</td>
<td>Resin</td>
<td>100 g/l</td>
</tr>
<tr>
<td>Sequawet 16</td>
<td>Surfactant for wetting</td>
<td>2 g/l</td>
</tr>
<tr>
<td>Mykosil LS-25</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

Pad Batch settings: 70 – 80 %, we used 75 %

Fixation with stenter (settings): Dried, then cured at 150 °C. The recipe said 164 °C, this showed signs of “yellowness”. This will be taken in consideration when evaluating the fabric.

Comments: Mykon HLC (PE emulsion for tear strength) was not delivered. This will be taken in consideration when testing the fabric. Mykosil LS-25 10g/l was added for potential better tear strength.
Appendix 24 – Texchem; Texfin CR

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous treatments</th>
<th>CHEMICAL SUPPLIER: Company</th>
<th>Trade name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing-cold bleaching-washing-alkaline treatment-washing-stentering</td>
<td>Texchem</td>
<td>Texfin CR</td>
</tr>
</tbody>
</table>

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texfin CR</td>
<td>Resin</td>
<td>200 g/l</td>
</tr>
</tbody>
</table>

Pad Batch settings: Pad at 70 - 80 % pick-up, we used 78 %.

Fixation with stenter (settings): Pad dry at 130°C and cure for 120 seconds at 150°C.
Appendix 25 – Texchem; Resin PLF

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatments

CHEMICAL SUPPLIER: Company

 Texchem

Trade name:

 Resin PLF

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin PLF</td>
<td>Resin</td>
<td>120 g/l</td>
</tr>
<tr>
<td>Texsoft PFS new</td>
<td>Softener</td>
<td>20 g/l</td>
</tr>
</tbody>
</table>

Total bath: 1l

Pad Batch settings: Pad at 70 - 80 % pick-up, we used 77 %.

Fixation with stenter (settings): Pad dry at 130°C and cure for 120 seconds at 160°C.
**Appendix 26 – Diazo; Quecodur FFL Plus**

Process work; IKEA crease resistant project  
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous treatments</th>
<th>CHEMICAL SUPPLIER: Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing-cold bleaching-washing-alkaline treatment-washing-stentering</td>
<td>Diazo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trade name:</th>
<th>Quecodur FFL Plus</th>
</tr>
</thead>
</table>

**Recipe for non-crease treatment**

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quecodur FFL Plus</td>
<td>Resin</td>
<td>120 g/l</td>
</tr>
<tr>
<td>Finistrol ESJ conc</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
</tbody>
</table>

| Total bath: | 1l |

**Pad Batch settings:** Pad at 80 % pick-up

**Fixation with stenter (settings):** Combined dry and curing in one stage at 130 °C for approximately 120 seconds.

**Comments:** The recipe says 60 seconds, but is not enough. This will be taken in consideration when evaluating the fabric.
Appendix 27 – Diazo; Quecodur SLF Plus

Process work; IKEA crease resistant project
Textile School of Sweden

<table>
<thead>
<tr>
<th>Material</th>
<th>Name of fabric</th>
<th>Process and machinetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton 50 %, Lyocell 50 %</td>
<td>Risp/365 +</td>
<td>Wrinkling finishing; Impergnation with Pad Batch and setting with stenter</td>
</tr>
</tbody>
</table>

Previous treatments

<table>
<thead>
<tr>
<th>CHEMICAL SUPPLIER:</th>
<th>Company Diazo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing-cold bleaching-washing-alkaline treatment-washing-stentering</td>
<td>Trade name: Quecodur SLF Plus</td>
</tr>
</tbody>
</table>

Recipe for non-crease treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quecodur SLF Plus</td>
<td>Resin</td>
<td>60 g/l</td>
</tr>
<tr>
<td>Finistrol ESJ conc</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Finistrol SFB</td>
<td>Softener</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Acetic acid</td>
<td></td>
<td>1 ml/l</td>
</tr>
</tbody>
</table>

Total bath: 1 l

Pad Batch settings: 70 – 80 %, we used 75 %

Fixation with stenter (settings): Dried at 130°C, then cured at 150 °C for 3 minutes.
Besöksadress: Bryggaregatan 17    Postadress: 501 90 Borås    Hemsida: www.textilhogskolan.se