How to take care of your rainwear

An evaluation of commercially available laundry and waterproofing agents and their effect on maintaining water-repellence.
Popular abstract
Rain jackets are common products on the outdoor market. There are many recommendations on how to maintain your garment in order to make sure that it keeps you dry, but the advice given by different sources is inconsistent. Are expensive products really necessarily or are regular laundry products just as good? What should you do use when your jacket does not keep you dry anymore?

Four different products that should make jackets repel water were tested on two different fabrics. Seven laundry products and two water-repellent products were tested on rainjackets and untreated fabrics. The results were evaluated by two different tests, spraying the fabric with water to see if it keeps dry and closely looking at the behaviour of a water droplet on the surface.

Not all water-repellent products offer good results on the tested fabrics. Two laundry products decreased the water-repellence of the jackets. The laundry products used did not affect the function of water-repellent products used on the jackets negatively. The water-repellence of one water-repellent product was affected negatively by the use of two different laundry products on untreated fabric.

Abstract
Breathable water-repellent garments are common products on the outdoor market. There are many recommendations on how to wash and waterproof your garment in order to make sure that its water-repellence is cared for, but the advice given by different sources is inconsistent. Are expensive products really necessarily or are regular laundry products just as good? What waterproofing agents should one use in order to insure that the water-repellent layer is restored?

Four different water-repellent wash-in products were tested on polyester and polyamide fabrics. Seven laundry products and two water-repellent wash-in products were tested on jackets with dendrimer based finishes and untreated polyamide fabrics. The results were evaluated by spray testing according to ISO EN 24920 and sessile drop tests.

Not all wash-in products offer good water-repellence on polyamide and polyester fabrics. Two laundry detergents decreased the water-repellence of the jackets. The laundry detergents did not affect the function of wash-in waterproofing agents on the jackets. The water-repellence of one wash-in product was affected by the use of two different detergents on untreated fabric.
Sammanfattning
Vattenavvisande plagg med andningsförmåga är vanligt förekommande i friluftsbranschen. Många rekommendationer finns om hur dessa plagg skall tvättas och återimpregneras för att försäkra att dess vattenavvisande förmåga består men informationen som ges skiljer sig markant från källa till källa. Är dyra tvättmedel verkligen nödvändiga eller fungerar vanliga lika bra? Vilka återimpregneringsprodukter skall användas för att försäkra sig att vattenavvisningen återställs?

Fyra olika återimpregneringar av wash-in typ testades på polyamid och polyester. Sju olika tvättmedel och två återimpregneringar testades på jackor med en dendrimer baserad finish och obehandlad polyamid. Resultatet bedömdes med hjälp av spraytest enligt ISO EN 24920 och kontaktvinkelmätningar

På obehandlad polyamid och polyester uppnåddes inte godkänt vattenavvisande effekt av alla impregneringsmedel. Två av tvättmedlen minskade jackornas vattenavvisande effekt. Tvättmedlen gav ingen negativ påverkan på återimpregneringsresultatet av jackan. Två olika tvättmedel som användes på ett obehandlat material visade ett negativt resultat på återimpregneringen.

Nyckelord/keywords: Water-repellent, waterproof, rainwear, impregnation, laundry, detergent, sessile drop, spray test
**Prefix**

The spray tests and drop tests according to the sessile drop method have taken place at the laboratories at the Swedish school of textiles in Borås.

The materials used for this thesis have been provided by Didriksons and F.O.V. Fabrics AB but all information in this report has been written independently.

I would like to thank my mentor during this thesis Mats Johansson. I would also like to thank Didriksons for offering jackets for testing and F.O.V. Fabrics AB for the supplying of fabrics.
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1. Introduction

1.1 Background

The surface of textiles used in outerwear for sports and leisure are often treated with hydrophobic chemicals in order to obtain their water repellence.

There are different types of chemicals that can be used as a water repellent finish on rainwear. Commonly used are fluorocarbons, dendrimers, silicones, waxes and polyurethanes.

1.1.1 Care of water-repellent garments

There is an uncertainty in what products that should be used for washing and waterproofing rainjackets. Retail, fabric manufacturers and sales of waterproofing agents all have different views on what products work best for these types of fabrics. Little is known about the ingredients and functions of the products available on the market.

There are many different brands and types of laundry detergents available on the market. In order to find out which of these are best and which should be avoided for the laundering of waterproof breathable garments, websites of several outdoor apparel manufacturers, retailers of outdoor gear and fabric manufacturers were checked. The information that was provided is presented in attachment 1.

The advice on the washing of breathable water-repellent garments that contain a dendrimer based water-repellent finish is slightly diffuse. Sympatex recommends their customers to use “fine” detergents or special detergents for functional textiles and Didriksons recommends the use of a “mild” detergent (Sympatex (n.d.)) & (Didriksons (n.d.)). Although the exact meaning of these notions remain undefined.

The recommendations for the washing of water-repellent breathable garments based on fluorocarbons vary highly. For example, on the website of Gore-Tex that manufactures a textile containing a PTFE membrane and a Polyurethane coating (A. Mukhopadhyay and V. K. Midha, 2008, pp. 17-41) the laundry detergent recommended was liquid detergent. It was stated that powder detergent should not be used. Gore-Tex (2013)

The laundry detergent told most suitable by the visited websites on the washing of Gore-Tex garments were: Powder detergents, non-detergent soaps, soap based products, mild detergent and “Free rinsing soap or non-detergent cleaning agent”. The products that should be avoided were told to be: powdered detergents, waterproof/breathable soaps or liquid soaps, normal laundry detergents, liquid detergents, products with surfactants, detergents and enzymes. This shows the confusion that seems to be common on what washing agent to use for the washing of water-repellent breathable garments.
At the same time, many specialized products for rainwear state to be specially developed for waterproof and breathable garments and should be used in order to maintain the water-repellence of the fabric.

Most outdoor apparel manufacturers, retailers of outdoor gear and fabric manufacturers in attachment 1 recommend re-waterproofing water-repellent clothing when the outer layer starts to absorb water. Some advice to waterproof after every wash (Duratec (n.d.) & eVent (n.d.)) or after some washes (stadium (n.d.)).

Sympatex states that fluorocarbon free waterproofing agents should be used on their fabrics with dendrimer based finishes (Sympatex (n.d.)). Didriksons, that also uses dendrimer based finishes, does not recommend any specific waterproofing agents. (Didriksons (n.d.)).

Some suppliers of waterproofing agents state that their products works best if washed with their matching specialty laundry detergent prior to waterproofing (Fibertec (n.d.), Nikwax (n.d.) & Grangers (n.d.))

1.2 Aim

The aim of this report is to find out which product one should buy to maintain the performance of water repellent jackets and dendrimer based water-repellents in particular.

The central questions that this thesis aims on answering are:

1. Can the use of the wrong type of laundry agent impair the water-repellent effect of rainwear?
2. Are speciality products better on preserving this water-repellent effect?
3. Which waterproofing agent should be used to improve the water-repellence when it has been impaired?
4. Does the choice of detergent prior to applying a waterproofing agent affect the results of the water-repellence?

1.3 Limitations

Only the water repellence of the fabrics involved has been checked, not the waterproof coating or the change on the breathability. Loss of breathability by the clogging of the pores in the breathable membranes can be possible when using the wrong detergents. This has not been checked. Oil and soil repellence has not been tested. The focus has been on how a customer would use the products involved, not on what is thought to be the most optimal way to use them. The focus has been on the maintenance of dendrimer based finishes, not fluorocarbon based, although literature studies and market research on fluorocarbon based finishes has been included in order to give an insight on the washing and caring of these types of products.
2. Theory

2.1 Water repellence

According to “The Encyclopedic Dictionary of Polymers” the meaning of waterproof is a term that can be applied to textiles that are impermeable to air and water, and thus are uncomfortable to wear. Water-repellent is explained in the dictionary as a fabric that is treated with an impermanent wax, resin or polymer treatment and is permeable to air but can shed water, and thus is comfortable to wear. (Gooch, J.W. 2011, pp 805)

By reducing the free energy at the fabric surface a water-repellent finish can give textiles water-repellent properties. In order for a drop of liquid to spread on a fabric, the cohesive interactions that occur within the drop must be less than the adhesive interactions that occur between the drop and the fibre. If the cohesive interactions within the drop are greater than the adhesive interactions between the fibre and the drop, the drop will not wet the fabric. So-called “low energy surfaces” are surfaces that show low interactions with liquids. In order for a surface to repel a liquid, the critical surface tension $\gamma_C$ (or surface energy) must be less than the surface tension of the liquid $\gamma_L$ that they intend on repelling. For water, $\gamma_L$ is 73 mN m$^{-1}$ and for oils $\gamma_L$ is 20-35 mN m$^{-1}$. The surface tension $\gamma_C$ of fluorocarbons is 10-20 mN m$^{-1}$ and for silicones the surface tension $\gamma_C$ is 24-30 mN m$^{-1}$. This is why fluorocarbons will repel oil and water but silicones will only repel water. (Schindler, W.D. & Hauser, P.J. 2004, pp 74-86)

Commonly rainwear has a water-repellent fabric construction with a micro porous polyurethane coating, PTFE (Polytetrafluoroethylene) laminate or hydrophilic polyurethane laminate on the back of the fabric. In order for this construction to be comfortable for the wearer it needs to let water vapour out of the fabric and at the same time keep water droplets out. (Mukhopadhyay, A, 2008. Pp 225-262). If only a water-repellent fabric construction is used without a water-repellent treatment at the face of the fabric the outer layer will absorb water and feel cold and clammy. Moisture absorption in the fabric also restricts the water vapour permeability of fabrics coated with PTFE (J.E. Ruckman 1997, pp. 151) but increases it in microporous polyurethane and hydrophilic polyurethane laminates (J.E. Ruckman 1997, pp. 151) (Ren Y.J 2003 pp.165-175)

Different types of water-repellent breathable materials are available on the Swedish market. Examples are brands like Cutan, Exodus, eVent, Gore-Tex, H2no, HiPe, Hyvent, Proof, TCS and Texapore AIR. These all have some type of breathable coating or membrane on the back on the fabric and a fluorocarbon based water-repellent on the face of the fabric. Brands like Sympatex, H&M and Didriksons use dendrimer based finishes in order to make their fabrics water-repellent. (Naturskyddsföreningen (2013))
2.2 Common water-repellents

2.2.1 Dendrimers

Several companies have started using dendrimers and promoting it as an environmentally
friendly alternative to the heavily debated fluorocarbon based finishes. The term “dendrimer”
does not necessarily mean fluorocarbon free. Dendrimers with fluorocarbons as active groups are
available (Rudolph Kemi (n.d.))

Dendrimers are hyperbranched molecules which have a central core molecule and branch
outwardly in a generation-wise, tree like, construction. Dendrimers can have the size of

There are several water-repellent finishes based on dendrimers available. Fluorocarbon free
durable water repellents based on dendrimer structures are for example bionic-finish eco from
Rudolf group, in which dendrimers with CH$_3$ groups are combined with “comb polymers” in
order to obtain a water repellent finish. (Rudolph Kemi (n.d.))

2.2.2 Fluorocarbons

Fluorocarbons are probably the most commonly used chemical for water-repellent finishes.
Fluorocarbon finishes make the textile water, soil and oil repellent and are fast and easy to apply.
(Schindler, W.D. & Hauser, P.J. 2004, pp 74-86) The environmental concerns about the usages of
fluorocarbons are widely known. PFOS (Perfluorooctanesulfonic acid) and PFOA (Perfluorooctanoic
acid) are examples of 2 types of fluorocarbons with 8 carbon atoms in their molecule backbone
that have been proven to be persistent, bioaccumulative and cancerogenic. (Naturvernförbundet
(2007))

Many textile suppliers and manufacturers have now stopped using these chemicals and replaced
them with PFOS and PFOA free alternatives. Although it is common that for example PFOA is
produced in the production of other, more “environmentally friendly” types of fluorocarbons as a
by-product or that fluorocarbons can break down to PFOA. This is the case with fluorotelomers
and FTOH (Fluorotelomers with an alcoholgroup) that have become common as replacement for
PFOS and PFOA. (Naturvernförbundet (2007))

Fluorocarbons with 6 carbons in their molecular backbone are often described as
environmentally friendly, but this doesn’t have to be the case. The environmental effects of less
common types of fluorocarbons are not as widely researched as PFOS and PFOA. PFHxS, the c6
equivalent of PFOS has proven to be persistent. (Lasier, P.J et al. (2011)).

2.3 Washing

In order to find out how water-repellent breathable clothing should be washed, some terms and
principles need to be explained. Washing affects both the coating or laminate on the inside of the
fabric, as well as the water-repellent finish placed on the outside.
The pores in breathable fabrics can get blocked and the outer surface altered by sweat, dirt, detergent residue and surfactants used in the cleaning process. This is only the case for microporous membranes, hydrophilic films and coatings do not lose their properties when cleaning the garments. In order to protect against dirt and washing, microporous breathable membranes can be covered with a hydrophilic film (Mukhopadhyay. A, 2008. Pp 225-262)

In order to prevent loss of water repellence by sweat and dirt the garment should be washed often. The laundry agents that are recommended in appendix 1 should ensure that the outer surface is not altered and the pores not blocked by detergent residue and surfactants used in the cleaning process.

Detergent residue can appear when too much detergent is used, when the rinsing cycle of the washing machine is not sufficient and when hard water reacts with sodium carbonates in washing detergents. (Bartos L. 1999)

The advice on washing, according to the companies mentioned in appendix 1, was to rinse twice after washing, in order to remove any remains of laundry agents from the fabric surface, and to avoid the use of perfumes, softeners and bleach.

So what are the differences between the laundry agents that are recommended in appendix 1? What do the terms liquid detergents, powder detergents, mild detergents, speciality detergents, soap based products and non-detergent soaps mean?

2.3.1 What is a detergent?

A laundry detergent is a product containing surfactants and other ingredients designed to clean fabrics. Detergency can be described as the removing of soil with the help of a surface active agent (surfactant). (Bajpai, D. & Tyagi, V.K. 2007, pp. 331)

The ingredients in detergents can vary but some key ingredients can be classified in to different groups, such as builders, surfactants, enzymes and bleaching agents. For detergents to work they must have a hydrophilic group to be soluble in water and a hydrophobic group in order to be soluble in oil. (Yadav, S. 1997)

The difference between powder and liquid detergent, except that one is in powder form and the other in liquid form, is that liquid detergents are more effective at cleaning oily soils whereas powder is more effective at removing clay and ground in dirt. Another difference is that liquid detergents may contain solvent liquids to help blend all the additives. (Bajpai, D. & Tyagi, V.K. 2007, pp. 331)

No specific definition was found on the meaning of “mild detergent” but is can be interpreted that a mild detergent should not contain harsh chemicals such as bleaching agents.
A product stating to be “non-detergent” technically should not contain any surfactants when compared to the definition of detergent. Often “non-detergent” is referred to when a product is based on soap instead of synthetically manufactured surfactants.

Specialty detergent can be interpreted as that the product is developed for a specific cleaning purpose, in this case for the cleaning of water-repellent breathable clothing. Most of these products are sold as liquids but no specific ingredients are linked to this term.

### 2.3.2 What is a surfactant?

The most important component group in detergents are surfactants. Surfactants in detergents enhance the wetting, foaming, dispersing and emulsifying properties of the detergent. In order to remove different types of soil, washing detergents often contain several different types of surfactants to optimize the cleaning function. (Bajpai, D. & Tyagi, V.K. 2007, pp. 327-340.)

Surfactants are the key ingredients in laundry agents. The recommendation by Arc’teryx in appendix 1, that the use of surfactants needs to be avoided, basically means that only water should be used while washing.

### 2.3.3 What is soap?

Soaps are anionic surfactants made from fats/oils and alkali. (Bajpai, D. & Tyagi, V.K. 2007, pp. 327-340.) Previously, before the introduction of synthetic surfactants, soaps were the main surfactant in laundry detergents, but since synthetic surfactants have more and more taken over. The main advantages of soaps are that they act as a water softener and prevent soil re-deposition and maintain whiteness. (Bajpai, D. & Tyagi, V.K. 2007, pp. 327-340.) Soaps are sensitive to water hardness which can cause accumulation of lime soap. This can reduce the air permeability of a fabric as well as its absorbency. The main function for the use of soaps in detergents is now as a foam regulator. (Smulders, E. 2002, pp 45)

Products that are called soap based or non-detergent can have soaps as their main surfactant. Soap can also be used in regular household laundry detergents.

### 2.4 Waterproofing

After laundering the factory applied waterproofing agent can be re-activated by heat treating the garment, such as tumble drying. Wear and tear can remove the water-repellent finish of a waterproof breathable fabric. This causes moisture to be absorbed in the outer fabric and is uncomfortable for the wearer and makes the garment feel cold and clammy. Moisture absorption in the fabric also restricts the water vapour permeability of fabrics coated with PTFE (J.E. Ruckman 1997, pp. 151) but increases the water vapour permeability of microporous polyurethane and hydrophilic polyurethane laminates (J.E. Ruckman 1997, pp. 151) (Ren J.J 2003 pp.165-175)

To minimize the absorption of moisture in the outer fabric the fabric needs to be re-impregnated
There are many different brands and types of re-impregnations products for the waterproofing of water-repellent breathable garments available on the market. Re-impregnations can be applied by spray, wash-in, or rub-in treatments and the active ingredients can be fluorocarbons, dendrimers and elastomers.

Earosol sprays are commonly based on fluorocarbons (Naturskyddsföreningen (2007)). Pump sprays are available by Nikwax, Fibertec and Grangers and are based on different active agents such as elastomers (Nikwax (n.d.)), fluorocarbon free dendrimers (Fibertec Greenguard) and C6 fluorocarbons (Fibertec Blueguard and Grangers) (Fibertec (n.d.)).

The recommendations on what products to use depend on the source consulted. Sprays are told to be a better solution if the garment has a lining that transports moisture (Marmot (n.d.)).
3. Method

A small qualitative evaluation of the recommended wash- and waterproofing agents on water-repellent outerwear was done and displayed in appendix 1.

3 quantitative evaluations were done to further investigate the advice obtained from the qualitative evaluation.

In order to find out the effect of different wash-in waterproofing products for home use these were tested on plain untreated polyester and polyamide fabrics. The results of these tests were evaluated by spray test and sessile drop test.

Untreated polyamide and polyester fabrics were treated with 4 waterproofing agent to find out the difference in water-repellence.

To see the effect of different laundry detergents on the water-repellent finish of a jacket these were tested on 6 rainjackets provided by Didriksbons. These rainjacket had a durable water-repellent finish based on dendrimers. The rainjackets were washed 4 times in 7 different detergents. After washing the jackets were tested by spray test and sessile drop test in order to discover any decrease in the water-repellence of the fabric. The jackets were cut in half and a waterproofing agent was applied to each half of the jacket. The results of the waterproofing agent were tested by sessile drop and spray test. The aim was to recreate the way a consumer would use these product. This was done by using jackets and not just fabrics.

A polyamide fabric was divided into pieces and washed in different washing detergents. After this the fabric was evaluated by spray test. The fabric was then attached to a jacket that was washed with the same detergent and waterproofed. This was done in order to find out the effect of laundry detergents on the ability of waterproofing agents to waterproof an untreated fabric.

3.1 Materials

3.1.1 Fabrics

White polyester multifilament weave and white polyamide weave were used in order to test the effect of different water-repellent wash-in products. These fabrics were chosen because of their smooth and even surface. Both fabrics were plain weaves but where not identical. The polyester weave was made of multifilament yarns and the polyamide was made of staple fibre yarns.

Blue polyamide weave was used for the testing of laundry detergents in combination with waterproofing agents. This fabric was chosen due to its current use in water-repellent products. The fabric was untreated and had a slightly striped structural surface. The fabric was tested with the stripes placed vertically to avoid the interference of the structure on the waterdroplets.
Before testing the fabrics were cut in pieces of 50x50 cm. These pieces were overlocked to keep the fabrics from ravelling during wash. A coloured thread was used on the bobbin to mark the wrong side of the fabric.

3.1.2 Jackets

6 rainjackets from Didriksons made from 100 % polyamide with polyester lining were obtained. The fabric has a water-repellent finish called bionic eco made by Rudolph kemi.

In order to test 7 detergent types on 6 jackets 1 of the jackets was cut in half at the back seam. The back seam and lining were overlocked together before washing to avoid the ravelling of the fabric and to keep the inside of the jacket covered by the lining.

The obtained rainjackets were stated to be in identical materials, although they had variations in colour. 2 pink jackets, 2 red jackets, 1 white jacket and 1 green jacket with white sleeves were received.

3.1.3 Washing machines

The laundry tests were done on a horizontal-axis drum-type washing machine of model Cylinda TMC 1000.

The application of the wash-in water-repellent have been done in a horizontal-axis drum type washing machine of model ASKO W64441

Tumble drying has been done in ASKO T754C

3.1.4 Washing detergents

The washing detergents used in these tests have been chosen upon their availability on the Swedish market and the recommendations stated in attachment 1

1. Powder detergent: Neutral concentrated colour wash, see attachment 2

2. Liquid detergent Neutral liquid colour wash, see attachment 3

3. Mild detergent: Maskintvätt Y3, ”fintvättmedel för ömtåliga textilier”, see attachment 4

4. Liquid speciality detergent for waterproof /breathable clothing; Atsko Sport-wash by sno-seal, scent destroying laundry detergent, see attachment 5

5. Liquid soap for waterproof /breathable clothing, Non detergent, soap based: Techwash, Nikwax, see attachment 6

6. Liquid speciality detergent for waterproof /breathable clothing: Grangers, see attachment 7
7. Liquid speciality detergent for waterproof /breathable clothing: Pro wash, Fibertec, see attachment 8

3.1.5 Water proofing agents

The focus in choice of waterproofing agents has been to mimic consumer behaviour. The products that have been used are picked because they are available on the Swedish consumer market.

Initially two types of aerosol spray impregnations were also tested but were later withdrawn from the test results. They were hard to spray on in a controlled and even way, a minimum of faster or slower movement of the hand when spraying could cause big differences in the amount that was sprayed on. No minimum or maximum amount of use was given on the packages of these sprays and also the spray-nozzle gave an uneven amount of spray. So these products could not be compared in a scientific way.

For this reason only wash in waterproofing were used in testing. By using wash-in products the washing machine applies the waterproofing agent and by choosing program according the directions given by the supplier of the wash/in product it is made sure that an objective application can be made.

A. Fibertec – Greenguard, see attachment A

B. Fibertec – Blueguard, see attachment B

C. Nikwax TX, see attachment C

D. Grangers, see attachment D

3.2 Testing

3.2.1 Laundring

All washing has been done in Cylinda TMC 1000. The laundry program “syntettvätt 40°C” (synthetic wash 40 °C) has been used. The laundry program has a total water consumption of 54 liters and takes about 25 minutes to finish. The laundry program consists of a main wash cycle, 3 rinse cycles and a spin dry cycle of 3 minutes (mhabnet (u.å.))

The fabrics have been washed 1 time each and the garments from Didriksons have been washed 4 times.
Before switching laundry detergents, the machine has been cleansed by a fast laundry program “kvicktvätt 40°C” (quick wash 40°C), in order to get rid of excess detergent residue. This program consists of a main wash and 2 rinsing cycles with a spin dry cycle of 3 minutes afterwards. (mmabnet (u.å.)) The detergent and softener compartment of the washing machine was washed with dishwasher soap and hot tap water before switching detergents.

3.2.1.1 Laundering of jackets

In order to determine how different detergent types affect the function of the DWR finish of the jackets laundry tests have been done. 4 washing cycles with a certain detergent have been done on each jacket to see the change this could cause on the lifespan of the water-repellent finish. The laundry detergents used are stated in attachment 2-8. A total of 4 times 7 washes has been done.

After 4 washings the garments have been dried on a hanger in a drying cabinet on high temperature. The dry jackets have been ironed in low temperature in order to make sure the water-repellent finish is fully revived and the surface even enough to allow measuring of the contact angle. The jackets have been washed in-side-out with all buttons and zippers closed.

The garments have been stored separately in open plastic bags to avoid contamination

3.2.1.2 Laundering of fabrics

In order to see if certain laundry detergent can interfere with the water repellent effects of waterproofing agents for home use a test has been done. 5 pieces of fabric have been washed at a time in 1 certain laundry detergent (see attachment 2-8). A total of 7 washes have been done.

After laundering the pieces have been tumble dried in normal temperature for 30 minutes.

The fabrics have been stored in open plastic bags in order to avoid contamination.

3.2.1.3 Laundry detergents

The dosage of the laundry detergents used has been based on the recommendation provided by the supplier. The assumption has been made that laundry detergent dosage is based on the amount of water used in the washing process. For the detergent that recommended a deterent amount per garment this amount was used. All laundry detergents have been added in the detergent compartment.

If different dosages are recommended for soft and hard water, the dosage for soft water has been chosen. The area of Borås, where the washing had been done, had soft water. (Borås energy och miljö (n.d.))

The washing machine Cylinda TMC 1000 that was used has a total washing capacity of 5 kg and a water usage of 65 litres in a “normal” 40°C or 60 °C wash cycle. The laundry program for synthetics in 40 °C that was used has a washing capacity of 2.5 kg and a water usage of 54 litres.
Neutral powder detergent: 65 ml detergent was recommended for 3-5 kg laundry in soft water. The washing cycle used had only 83% of the water-consumption compared to the program the detergent was recommended for, so the amount of detergent was decreased to 83% of the total amount. 54 ml was used.

Neutral liquid detergent: 40 ml was recommended for 4-5 kg wash in soft water. 83% of the total amount is 33.2. 33 ml was used.

Y3: 50 ml of detergent is recommended for 2-3 kg of laundry. The laundry program that was used had a capacity of 2.5 kg so 50 ml was used.

Atsko Sport: 1 bottle cap, ±30 ml wash recommended for one wash. 30 ml was used.

Nikwax Techwash: 100 ml of laundry detergent was recommended for a maximum of 2 garments. 100 ml was used.

Grangers: 1 bottle cap of 50 ml was recommended for 1 jacket. 50 ml was used.

Fibertec Pro wash: 25 ml detergent is recommended in soft water (no laundry amount specified). 25 ml was used.

3.2.2 Waterproofing

Waterproofing has been done in ASKO W64441. This machine was chosen because its rinse cycle only involved one rinse, instead of two, avoiding rinsing out the newly applied waterproofing agent. Tumble-drying has been done in ASKO T754C.

Medium tumble drying temperature corresponds with a temperature between 60 °C and 80 °C. Low temperature corresponds with a tumble-drying temperature below 60 °C.

The detergent and softener compartment of the washing machine has been cleaned with dishwasher soap and hot tap water between each waterproofing cycle.

3.2.2.1 Waterproofing of untreated materials

The white untreated polyester and polyamide fabrics were waterproofed to see which waterproofing agents that show the best effect. 4 waterproofing agents of wash-in type were used.

1 piece of polyester fabric and 1 piece of polyamide fabric were waterproofed together according to the recommendations provided on the package of the waterproofing agents (see appendix A-D).
Nikwax Techwash: 100ml waterproofing agent was used in the detergent compartment of the washing machine, synthetic wash program in 30°C, spin cycle at 400 RPM. Tumble-drying was done in 30 minutes in low temperature.

Grangers: 100 ml waterproofing agent was used in the detergent compartment of the washing machine, a synthetic wash program with a spin cycle off 400 RPM was selected. Tumble-drying was done at normal temperature in 30 minutes.

Fibertec Glueguard: 50 ml waterproofing agent was used in the softener compartment of the washing machine, a rinse program with a spin of 800 RPM was selected. Tumble-drying was done in 30 minutes at normal temperature.

Fibertec Greenguard: 50 ml waterproofing agent was used in the softener compartment of the washing machine, a rinse program with a spin of 800 RPM was selected. Tumble-drying was done in 30 minutes at normal temperature.

3.2.2.2 Waterproofing of laundered materials

Two waterproofing agents were picked out for the waterproofing of the jackets. Fibertec Greenguard wash-in (see appendix A) and Fibertec Blueguard wash-in (see appendix B). These agents were chosen because of several reasons. The key reason is that dendrimer based waterproofing agents are recommended by Sympatex on the waterproofing of their dendrimer water-repellent fabric. Fluorocarbons of c6 type are common among the waterproofing agents sold on the Swedish market so this is a realistic treatment to be chosen by a costumer.

Both products are provided by the same brand and have the same application process, which simplifies the application process and the comparison of the results. These products also had a shorter application process, with only a rinse cycle, compared to the other products that were bought, that had to be washed in.

All jackets were cut in half at the back of the garment and overlocked with a seam attaching lining and outer-fabric. All right sides were waterproofed in Fibertech Greenguard and all left sides in Fibertec Blueguard. On the garment that was already cut in half prior to the washing test the sleeve was cut loose from the body of the jacket. The cut seam was overlocked and the sleeves were waterproofed with Greenguard, the body with Blueguard.

The washed jackets from Didriksons have been waterproofed in the same cycle as the blue fabrics that were washed by using the same laundry detergent. Prior to waterproofing the fabric and jacket have been attached to each other to simplify the handling process. This attachment was done by a 10 cm long seam at the bottom of the garment and the edge of the fabric.

The waterproofing method used was as following: 50 ml waterproofing agent was used in the softener compartment of the washing machine, a rinse program with a spin of 800 RPM was selected. Tumble-drying was done in 30 minutes at normal temperature.
3.2.3 Drying and conditioning

All samples have been kept separated in order to avoid contamination between the samples.

To be able to register the contact angle between the water droplet and the fabric with the camera in the sessile drop test the fabric needs to have a very smooth surface. To obtain this the surface of all fabrics that were tested in the sessile drop method have been ironed on low heat prior to testing.

The samples have been placed in the room where the test have taken place 24 hours prior to testing. These rooms have not had a controlled climate, but by keeping all samples in the same climate before test the difference in moisture content and temperature between the samples has been minimized.

3.2.4 Spraytest

In order to find out and compare the changes in water-repellence of the fabrics, tests have been done according to ISO SS-EN 24920 (Textiles. Determination of resistance to surface wetting (spray test) of fabrics).

The fabric was attached to a plastic ring. The ring was placed in a holder at an angle of 45 °. Above the holder a funnel with a spray nozzle was placed. The funnel was filled with 250 ml water at 20°C. The water ran on to the fabric. When the funnel was empty the fabric and its ring were taken from the holder and firmly tapped to the edge of the sink twice with the face side of the fabric down faced. The amount of water left on the fabric was estimated according to a visual reference scale.

All tests were done on the face of the fabric with the warp of the fabric placed in the slightly vertical direction and the weft in the horizontal direction.

The spray rating the samples were judged upon was according to the standard:

1. The whole of the sprayed surface is wetted
2. Half of the sprayed surface is wetted, normally this occurs when small wetted areas are merging
3. Small discrete areas of the surface are wetted
4. Small drops are adhered to the sprayed area but no wetting occurs.
5. The sprayed surface is free of drops and is not wetted. (ISO EN 24920)

3.2.4.1 Exceptions from the standard

For the spraytesting of the rainjackets the standard ISO EN 24920 has been followed for most of the testing procedure except for some exceptions. The amount of fabric available for spraytesting
on the jackets has been limited. Therefore the tests done before washing and after washing have taken place with the whole garment placed on the testing ring, the garment still intact. The fabric surfaces smooth enough not to affect the water-repellence were used for spray testing.

The fabrics have not been conditioned according to the standard. No standard temperate atmosphere was measured in the room of testing for any of the tests taken.

For the test after impregnation the jackets have been cut in suitable pieces for the size of the spray testing ring. On some garments the available materials had been limited so only 2 tests could be taken instead of the 3 stated in the standard.

3.2.4 Sessile drop test

To calculate the change in surface tension of the fabrics that occurred after washing and waterproofing a measurement of the contact angle between the fabric and a drop of tap water has been done. These test were done with the use of a tensiometer. The test was done with a optical tensiometer made by Attension. This particular tensiometer records images of the drop placed on the fabric and the provided software automatically analyses the shape of the drop.

Figure 1: placement of the baseline.

A piece of fabric with the dimensions of 4 by 4 cm was placed on the holder of the tensiometer. Fabrics that tended to curl, and thus block a good vision of the camera on the droplet were taped to the holder.

A drop of tap water of 3 µm is placed on the face side of the fabric. The placed droplet is backlit by a LED light which optimizes the vision of its contours. The camera starts recording when the droplet is placed on the fabric and stops recording after 10 seconds. This film is analysed in the OneAttension software provided for this machine. In the software a baseline for the exact
placement of the droplet on the fabric is marked manually by placing a line on the digital picture (fig 1). This exact choice of placement is visible because the picture has a sharp focus on this point of the fabric. After the placement of the baseline the data is analysed by calculating the angle that occurs between the baseline and the outline of the droplet and plotted to a table.

The plotted table showed an exact correspondence point to the pictures taken so it can easily be checked at what point in the process which angle has been measured. The values occurring on the beginning of the recording were not selected because the tendency of the water droplet to “bounce”, causing the angle to vary from high to low values, a couple of times until remaining still. From each sessile drop test about 120 values of contact angles were plotted. From these values about 24 values at the beginning of the plotting were removed as the water droplet was not yet stabilized on the fabric. The remaining values were checked if measured correctly.

The angles that occurred after the droplet was placed on the fabric and remained still were selected (manually) and the mean value was calculated (by the program). On each fabrics 3 sessile drop tests were done and thus 3 mean values were calculated per fabric.
4. Results

The results of the spray and sessile drop tests displaying the water-repellence obtained by water-repellent agents A-D on untreated polyester and polyamide weave are displayed below. In figure number 2 the sprayrates from 1 to 5 are shown in the vertical axis and the material/waterproofing agent combinations are displayed in the horizontal axis. A sprayrating of 1 means the whole fabric surface became wet and a rating of 5 means the fabric staid dry. A rating of 4 or 5 means the fabric is water-repellent. 3 spraytests were done on each material combination.

Figure 2: Spray ratings of waterproofed PES and PA fabric

Figure 3: mean value of measured contact angles on waterproofed PES and PA fabric

Figure 2 shows that the untreated polyester and polyamide fabrics had a spray rating of one, and thus were not water-repellent. After waterproofing the different waterproofing agents showed a varying result. 3 of the tested combinations showed insufficient water repellence after waterproofing. Fibertec Greenguard and Nikwax T.X Direct on polyester, Fibertec Blueguard on polyamide. The only waterproofing agent giving a water-repellent result on both polyester and polyamide was the fluorocarbon based Grangers.
Figure 3 shows the results of the contact angle measurements on polyamide and polyester fabrics. The horizontal axis shows the material combinations and the vertical axis the mean value of the measured angles. It can be seen that waterproofing agent Grangers obtained the highest contact angles. It can also be seen that the contact angles in figure 3 do not directly translate to the sprayratings seen in figure 2.

An ANOVA (analysis of variance) was done on the results obtained from the sessile drop tests done on the jackets to see if the obtained data was significant.

The p-value obtained from the ANOVA of the washed jackets showed a value of 0.481285, this value is very high (above 0.25) which shows that this factor is not significant. There was a high variation detected between the values obtained from the sessile drop tests done on the jackets washed with Grangers (a variance of 146.87) and Fibertec Pro wash (a variance of 179.29), both of these tests were done on the same jacket, each on 1 half and there is a change that the surface of this particular jacket was inconsistent. When an ANOVA was done on the washed jackets without the result of this jacket the p-value instead became 0.014532 and thus the difference in the tested jackets was significant (below 0.05).
After waterproofing the p-value for the jackets waterproofed with Fibertec Greenguard was 0.046356 and for Fibertec Blueguard 0.001083 which proves that the differences in results from these tests were significant.

Figure 4, where 1 = unwashed, 2 = after 4 washes and 3= after waterproofing, shows that the jackets washed with Y3 and Nikwax Techwash had the lowest contact angles after wash. The garments washed with Neutral powder detergent and Neutral liquid detergent had the highest contact angles.

The contact angles obtained after waterproofing were overall higher for the garments waterproofed with Fibertec Blueguard than for Fibertec Greenguard. The garments that showed among the lowest contact angles after wash ended up amongst the higher ones after waterproofing. The garments with contact angles among the highest ended up with lower contact angles after waterproofing.

Figure 5 shows the test results of the spray tests on the washed jackets. All jackets showed a spray rating of 4 in their unwashed state which means that only small drops were formed on the fabrics but they did not wet the surface. After washing some differences appeared in the performance of the fabrics. The jacket that was washed with Y3 detergent performed poorly in the test and with the spray rating of 2 on 2 of 3 tests, meaning that half of the sprayed surface was actually wetted. If this figure is compared to fig 4 one can see that Y3 also had the lowest contact angles in the sessile drop test. Also the garments washed with Nikwax Techwash showed a spray rating under the accepted level.

![Spray ratings of washed jackets](image)

Figure 5: spray ratings of washed jackets

Figure 6 shows the results of the spraytest on the washed and waterproofed jackets. This shows that all waterproofed jackets showed good water-repellence with a spray rating higher than 4.
Figure 6: spraytests on washed and waterproofed jackets

Figure 7: spraytest on washed and waterproofed polyamide fabric

Figure 7 shows the obtained spray ratings of the polyamide fabric that has first been washed and then waterproofed. The results show that most combinations of waterproofing agent and laundry detergent give a water-repellent result of 4. There are 2 laundry detergents that have affected the results of the fluorocarbon based waterproofing agent Fibertec Blueguard negatively. These are Y3, which gives a spray rating of 2, and Nikwax, with a spray rating of 3.

Both Nikwax Techwash and Y3 showed a lot of foaming during laundring. Especially the garment washed with Y3 that even after the finished washing cycle had foam left on the surface of the garment.
4.1 Price

### 4.1.1 price per wash load

<table>
<thead>
<tr>
<th>Detergent</th>
<th>price (SEK)</th>
<th>volume (ml)</th>
<th>recommended dosage (ml)</th>
<th>recommended load</th>
<th>price per load (SEK per wash load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral powder</td>
<td>23,9</td>
<td>1170</td>
<td>65</td>
<td>3-5 kg</td>
<td>1,327777778</td>
</tr>
<tr>
<td>Neutral liquid</td>
<td>32,9</td>
<td>1000</td>
<td>40</td>
<td>4-5 kg</td>
<td>1,316</td>
</tr>
<tr>
<td>Y3</td>
<td>25,9</td>
<td>500</td>
<td>50</td>
<td>2-3 kg</td>
<td>2,59</td>
</tr>
<tr>
<td>Atsko</td>
<td>99</td>
<td>532</td>
<td>39,5</td>
<td>&quot;1 washload&quot;</td>
<td>7,35056391</td>
</tr>
<tr>
<td>Nikwax techwash</td>
<td>100</td>
<td>300</td>
<td>100</td>
<td>2 jackets</td>
<td>33,33333333</td>
</tr>
<tr>
<td>Fibertec prowash</td>
<td>119</td>
<td>250</td>
<td>25</td>
<td>&quot;1 washload&quot;</td>
<td>11,9</td>
</tr>
<tr>
<td>Grangers</td>
<td>100</td>
<td>300</td>
<td>30</td>
<td>1 jacket</td>
<td>10</td>
</tr>
</tbody>
</table>

The cheapest detergents tested were Neutral powder and Neutral liquid detergent with about 1,32 per wash load. The most expensive ones were Nikwax Techwash and Grangers with around 10-16,5 SEK per wash of one garment.

### 4.1.2 price per waterproofing

<table>
<thead>
<tr>
<th>Waterproofing agent</th>
<th>price (SEK)</th>
<th>volume (ml)</th>
<th>recommended dosage (ml)</th>
<th>price per load (SEK per load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibertec Greenguard</td>
<td>179</td>
<td>250</td>
<td>50</td>
<td>35,8</td>
</tr>
<tr>
<td>Fibertec Blueguard</td>
<td>219</td>
<td>250</td>
<td>50</td>
<td>43,8</td>
</tr>
<tr>
<td>Nikwax</td>
<td>159</td>
<td>300</td>
<td>100</td>
<td>53</td>
</tr>
<tr>
<td>Grangers</td>
<td>100</td>
<td>300</td>
<td>100</td>
<td>33,33333333</td>
</tr>
</tbody>
</table>

The cheapest waterproofing agent was Grangers and the most expensive one was Nikwax T.X Direct.
5. Discussion

5.1 Occurred processes

The results from the spray tests and sessile drop method show that laundry agents Nikwax Techwash and Y3 decreased the water-repellence of the jackets. These 2 laundry agents had in common that they produced foam during washing. Nikwax was mainly soap based, which can cause residues. (Smulders, E. 2002, pp 45) and Y3 was the only detergent containing perfume, which according to some sources in appendix 1, should be avoided. Interestingly both of these detergents obtained amongst the highest results in surface tensions after waterproofing. There are 3 possible hypotheses for this:

1. Both laundry detergents washed away the original treatment, leaving the fabrics original surface exposed so the surface tension decreased. During waterproofing the (water based) waterproofing agents could penetrate the fibres because of the lack of protecting surface. This caused the surface tension to increase.
2. Both laundry detergents left a residue on the garment, this residue is hydrophilic, and thus lowers the surface tension. During waterproofing the waterproofing agents react with and attach to this hydrophilic residue layer, causing the surface tension to increase.
3. Both laundry detergents left a residue on the garment, this residue is hydrophilic, and thus lowers the surface tension. During waterproofing the residue is removed exposing a still intact original waterproof finish. The new waterproofing adds upon the waterproofness of the original layer and thus increases the surface tension.

If looked upon the results of the spray tests of the washed and waterproofed fabrics, it is shown that the fabric washed with Y3 showed a decrease when waterproofed with Fibertec Blueguard, instead of an increase that was noted before. This decrease shows the proof that hypothesis 1 can be discarded, the fabrics in this test were untreated to begin with, but showed an inferior result to the other samples tested. This decrease in water-repellence in the spray test of the fabric was also shown on the fabric washed with Atsko Sportwash.

If hypothesis 2 is true, the waterproof layer applied to the jackets washed with Nikwax Techwash and Y3, because only attached to residue, should show a decrease in water-repellence after additional wash or rinse cycles. This would mean that the higher water-repellence is not lasting and thus a disadvantage for costumers.

5.2 Difference in methods

A difference between spray test and sessile drop method was noted. High or low values on one of these tests did not necessary show in the results of the other test. This is for example the case in the test of waterproofing agents on untreated fabrics, where the fabrics with insufficient water-repellence when sprayed did not show lower contact angles. The main difference between these tests is that one of them is static and one dynamic. In the sessile drop method a droplet is placed
carefully on the surface but in the spray test the drops hit the surface with impact. The spray tests give a closer indication on what actually happens when rain falls down on the fabric. Another difference is that on the sessile drop method the behaviour of the droplet is only studied in 10 seconds whereas in the spray method the fabric is exposed for a longer period of time.

5.3 Colours

The jackets that were used in this test were of 4 different colours. One of the tested jackets (washed in Atsko Sport-wash) had white sleeves and a coloured body. In the sessile drop test the results from the body and the sleeves showed different results. The results from the sleeves were closer to the results from the white jacket washed in Nikwax Techwash than the results from the green body. Therefore the possibility was tested that the results in contact angle and spray tests were more depended on colour than on the used detergent. An ANOVA was done on the results of the sessile drop test of the new jackets. This ANOVA showed a value of 0.001134 and this difference between colours before wash was significant (above 0.005). This can be due to the fact that different colours are put through different processes in the processing plant that affect the surface tension of the fabric. The different fabrics could also have had different storage times which have affected the surface treatment.

The hypothesis of the jackets after laundering being affected by colour could not be calculated by ANOVA as the different colours had different amounts of test results. This hypothesis was still partly discarded to the facts that 1. In the spray test done the jackets with deviant results were of different colour and 2. The results separated by detergent after wash were significant (when one irregular garment was deducted). This hypothesis was not discarded completely and there is still a slight possibility that both colour and detergent have had an effect on the results.

5.4 Price

The price of the different detergents used varied highly. Of the detergents that showed decreased results in water-repellence one, Nikwax Techwash, was the most expensive laundry agent at 16.67 SEK per washed garment, the other, Y3, costs about 2.59 per wash load of 2-3 kg. The highest contact angle after wash in the sessile drop method was from Neutral powder detergent, that costs 1.32 per washload of 4-5 kg.

Of the waterproing agents Grangers, that had the lowest price, gave the best results on untreated fabric. Fibertec Blueguard that had varying results on untreated and washed fabrics was the most expensive one.

5.5 Spray tests

A sprayrating of 4 and 5 are both approved results that show good water-repellence. The difference according to the standard is that on a value of 4 small droplets are allowed to show on the surface whereas in a rating of 5 there should be no remaining droplets. The force that is used
to tap the specimen to the side of the sink can affect how many droplets that remain on the fabric, and this force can vary from specimen to specimen.

5.6 Sessile drop test

5.6.1 Uneven surface

Some fabrics of the jackets provided by Didriksons had a tendency to curl. This curling tendency was a problem in the sessile drop test as it caused problems for the camera to register the surface of the fabric. Fig 8 shows a red fabric placed on the holder in the sessile drop testing machine. Although this fabric just looks slightly bend here the effect of this slight bending is shown in fig 8 that displays what the camera registers. On this picture you can see that hardly any clear surface can be registered because of the bending of the fabric.

The sessile drop measuring apparatus also had issues with calculating the angles between the drop and the fabric surface. Fibres sticking up from the surface cause the computer to calculate the contact angle from the wrong points. This was especially the case if the fabric showed a “fuzzy” surface on the camera. In this case, when calculating the angle, the computer could not register the correct placement of this angle and it looked like angles were basically “made-up”. When this happened the test was redone.

5.6.2 Absorption

The fabric can absorb water which causes swelling. Swelling makes the fabric rise and causes the contact angle to change. If much swelling occurs the baseline from which the angles are calculated needs to move up in order to keep a correct reference point. If the baseline is not
moved up the angles cannot be calculated and this results in fewer measurements being calculated.

Fabrics with low contact angles absorb the sessile drop quickly. In these cases the drop can have disappeared completely from the surface within 10 seconds. In these cases the surface angle calculated is the mean value between the angle when the drop was applied to the fabric until the drop could not be calculated anymore. This occurred on the untreated materials of PA and PES.

5.7 Future developments
The hypothesis that the laundry detergents left a hydrophilic layer on the garment and the waterproofing agents attach to this hydrophilic layer, causing the surface tension to increase would be an interesting topic for future research. Tests of this hypothesis can easily be performed by wash tests of garments of this type.

An investigation on the exact substances and active agents in speciality laundry products for functional clothing is needed in order to find out the exact reaction occurring in the laundry process and their effect on the functionality of these garments.

A test of the change in water vapour permeability of waterproof/breathable fabrics after the use of different laundry agents would be relevant.

A similar test with different types of factory applied finishes, for example fluorocarbon based, would be interesting in order to find out if the test results will be comparable with the ones in this test.

A washing test on water-repellent garments including more wash cycles to make sure the factory applied water-repellent is completely removed while testing the water-repellent performance after each wash would be interesting, this way the effect of the detergents on the lifespan of the water-repellence can be monitored closely and an accurate advice can be given on what detergents not to use on these types of garments.

5.8 Source credibility
The information from the manufacturers of laundry detergents and waterproofing agents on environmental- and performance claims should be taken with precaution as they are not backed up with facts from independent institutes. These sources were used to give an insight and overview of the information consumers of these products can access.

It should be noted that the advice of retailers on which detergents and waterproofing agents to use on breathable water-repellent garments can be highly misleading. Many retailers of outdoor gear also sell specialized detergents and the promoting of those lead to direct profit. Even the advice on which re waterproofing agent to use can be deceptive as some products can be more profitable to sell than others. The producers of waterproof repellent garments have higher
credibility as they have an interest in showing the best performance of garments. Even the advice of these sources can be taken with certain caution as they can work in collaboration with garment producers and textile producers. These sources were used to give an insight in the information that is communicated to consumers on this matter.
6. Conclusions

Detergents and laundry soaps play a role in maintaining the factory applied water-repellent. Two detergents, Nikwax Techwash and Y3, showed a decrease in water-repellence of the factory applied finish after 4 washes.

The test results show that the use of special detergents, in order to maintain the waterproof function of dendrimer finishes, is not necessary. Some cheaper conventional products show similar results.

Not all wash-in water-repellents work on untreated materials. The fluorocarbon free agents Fibertec Greenguard and Nikwax T.X Direct have problems on polyester and Fibertec Blueguard on polyamide. On the waterproofing of jackets both fluorocarbon free Fibertec Greenguard and fluorocarbon based Fibertec Blueguard give a water-repellent end result.

On polyamide that was laundered, Fibertec blueguard showed issues in water-repellence in combination with 2 laundry detergents, Atsko Sportwash and Y3. This means that the choice of laundry agent prior to waterproofing can affect the function of the waterproofing agent. Laundry agents only play a small role in the ability of a garment of this type to be treated with water-repellent agents.
Sources


Didriksons (n.d.) Care Instructions http://www.didriksons.com/article.asp?c=1&aTabIndex=2&cmd=guide&sizeId=-1&typeId=-1&usageId=-1&systemId=-1 [2013-04-30]

durAtec (n.d.) Care Instructions http://www.duratec.se/?page_id=16 [2013-04-30]


(ISO EN 24920)


Appendix

1 advice on washing and waterproofing from different sources
2-8 specifications of used laundry detergents 1-7
9-12 specifications of waterproofing agents A-D
<table>
<thead>
<tr>
<th>Source</th>
<th>Type of source</th>
<th>Type of product advised upon</th>
<th>Advice on washing</th>
<th>Advice on waterproofing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go outdoors.co.uk</td>
<td>outdoor store</td>
<td>waterproof garments</td>
<td>non detergent based products</td>
<td>grangers extreme wash-in is recommended, should be used &quot;little and often&quot;</td>
<td></td>
</tr>
<tr>
<td>REI.com (REI (2012))</td>
<td>outdoor store</td>
<td>Gore-Tex outerwear</td>
<td>powder detergent, special &quot;waterproof/breathable&quot; soaps or liquid soaps should not be used</td>
<td>when the original repellent treatment is depleted, spray-on or wash-in repellent treatments</td>
<td></td>
</tr>
<tr>
<td>Kevin Thomson from Strathcona outfitters</td>
<td>outdoor store</td>
<td>Gore-Tex outerwear</td>
<td>non detergent soaps such as Nikwax</td>
<td>sprays and wash-in &quot;sprays will not last as long&quot;</td>
<td></td>
</tr>
<tr>
<td>Stadium (Stadium (2011))</td>
<td>outdoor and sports store</td>
<td>outerwear</td>
<td>gentle detergent</td>
<td>after some washes. Reproofing agents can be found in their store. (Grangers is sold)</td>
<td></td>
</tr>
<tr>
<td>eVent (eVent (2013))</td>
<td>Water-repellent fabric manufacturer</td>
<td>eVent fabrics</td>
<td>liquid detergent, with a second rinse cycle</td>
<td>&quot;regular treatments&quot;</td>
<td></td>
</tr>
<tr>
<td>Sympatex (Sympatex (uk))</td>
<td>Water-repellent fabric manufacturer</td>
<td>SympaTex fabrics</td>
<td>fine detergent or special detergent for functional textiles should be used</td>
<td>when the fabric ceases to form beads, spray on or wash-in. Fluorocarbon free products should be used for the reimpregnation of fabrics with fluorocarbon finishes</td>
<td></td>
</tr>
<tr>
<td>Gore-Tex (Gore-Tex (2013))</td>
<td>Water-repellent fabric manufacturer</td>
<td>Gore-Tex fabrics</td>
<td>liquid detergents, rinse twice. Do not use powdered detergents</td>
<td>pump-spray or wash-in product, when dwr stops working</td>
<td></td>
</tr>
<tr>
<td>DurAtec (DurAtec (uk))</td>
<td>Water-repellent fabric manufacturer</td>
<td>durAtec fabrics</td>
<td>use mild detergent, rinse twice</td>
<td>use repellency restorative product, preferably after each wash</td>
<td></td>
</tr>
<tr>
<td>Didriksons (Didriksons (uk))</td>
<td>Garment manufacturer</td>
<td>Storm-system garments, Dendrimer finish</td>
<td>&quot;gentle detergent&quot;</td>
<td>no recommendation of one product over another&quot;, should be used when waterrepellent stops working</td>
<td></td>
</tr>
<tr>
<td>Patagonia (Patagonia (uk))</td>
<td>garment manufacturer</td>
<td>waterproof/breathable shells</td>
<td>in general for all patagonia products: mild powder laundry soap</td>
<td>grangers products are recommended, spray on for 2 layer garments and wash-in for 3 layer garments. when waterrepellent stops working or once per season</td>
<td></td>
</tr>
<tr>
<td>The North Face (The North Face (uk))</td>
<td>Garment manufacturer</td>
<td>Gore-Tex</td>
<td>soap based product, two rinse cycles</td>
<td>after extendet use, reproofing product</td>
<td>two different recommendations depending on type of product</td>
</tr>
<tr>
<td>Haglofs (Haglofs (uk))</td>
<td>Garment manufacturer</td>
<td>Gore-Tex, Haglofs Proof and Windstopper</td>
<td>no detergent specified</td>
<td>when the outer surface is being soaked, re-waterproofing agents for breathable garments</td>
<td></td>
</tr>
<tr>
<td>Norrona (Norrøna (uk))</td>
<td>Garment manufacturer</td>
<td>Gore-Tex garments</td>
<td>mild detergent, no rinsing agents, rinse twice</td>
<td>when not performing optimally, or after wash. Spray is recommended to make sure only the outside of the product is waterrepellent to optimize moisture transportation</td>
<td></td>
</tr>
<tr>
<td>Arc'teryx (Arc'teryx (uk))</td>
<td>Garment manufacturer</td>
<td>Gore-Tex garments</td>
<td>free rinsing soap or non-detergent cleaning agent, for best result the product should be free of surfactants, detergents, enzymes, perfumes. Cleaning agent specially made for Gore-Tex fibers is recommended, such as Grangers performance wash, Fibertec Pro Wash and ReviveX Synthetic Fabric cleaner. If normal laundry soap is used rinse twice after washing.</td>
<td>when the garment is not shedding water like it used to, wash-in waterproofing agents are not recommended, sprays from Grangers Tx waterproofer, Fibertec Blue Guard and ReviveX spray on water repellent are recommended</td>
<td></td>
</tr>
<tr>
<td>Marmot (Marmot (2012))</td>
<td>Garment manufacturer</td>
<td>Gore-Tex shell</td>
<td>&quot;wash-in Grangers G-wash Cleaner Plus&quot;, not normal laundry detergents because they contain fragrance and colour brighteners. A mild powdered detergent is acceptable if thoroughly rinsed. The use of liquid detergents is not recommended because of its ability to clog the pores of the Gore-Tex and causes leakage, for non-Gore-Tex garments liquid detergents are okay. two rinse cycles are recommended.</td>
<td>wash-in or spray on versions of &quot;Grangers Waterproofing for Synthetic Fabrics&quot; are recommended for waterproofing. Spray on is recommended for products with a wicking lining</td>
<td></td>
</tr>
</tbody>
</table>
Specifications
Product name: "Neutral concentrated color wash"
Manufacturer: Unilever
Sales point: ICA
Price: 23.90 SEK
Type: powder detergent

Dosage
Volume: 900 g = 1.17 liter
Amount recommended per wash load: 65 ml per 3-5 kg in soft water
price per wash load: 1170 g/65 g = 18 washes, 23.90/18=1.33 SEK per wash load

Notes

Ingredients:
Free from colorants and perfumes
>30% zeolite
5-15 % nonionic tensides
<5 % soap, polycarboxylates, fosfonates, enzymes
Zeolite, Sodium Carbonate,Sodium Sulfate, C12-15 Pareth-7, Aqua, Sodium Tallowate, Maleic Acid-Acrylic Acid Copolymer, Sodium Salt, Sodium Citrate, Tetrasodium Etidronate, Sodium EDTMP, Protease, Amylase, Lipase, Cellulase.
Datasheet Laundry Detergent 2

Specifications
Product name: ”Neutral liquid colour wash”
Manufacturer: Unilever
Sales point: ICA
Price: 32,90 SEK
Type: liquid detergent

Dosage
Volume: 1 liter
Amount recommended per garment: 40 ml
per 4-5 kg wash in soft water (<8 dH)
price per wash load: 1000 ml/40 ml = 25
washes. 32,90 / 25 = 1.32 per wash load

Notes

Ingredients:
Free from colorants and perfumes
15-30 % nonionic tensides
5-15% anionic tensides
<5% soap

Aqua, Fatty Alcohol Ethoxylate, Sodium Laureth Sulfate, Alcohol, Potassium Hydroxyde, Citric Acid, Triethanolamine,
Sodium EDTMP, Sodium Hydroxide, PVP,
Calcium Chloride, Subtilisin, Amylase.
Datasheet Laundry Detergent 3

**Specification**
Product name: ”Y3 fintvättmedel för ömtåliga textilier.”
Manufacturer: Unilever
Sales point: ICA
Price: 25,90
Type: liquid detergent

**Dosage**
Volume: 500 ml
Amount recommended per wash load: 50 ml for 2-3kg laundry in soft water
Price per kg of laundry: 500/50 = 10 washloads, 2,6 SEK per wash load

**Notes**
Biodegradable surfactants.

**Ingredients:**
Does not contain enzymes, bleach, optical whiteners or phosfates.

Contains:
5-15% anionic tensides
<nonionic tensides
perfumes
Datasheet Laundry Detergent 4

Specifications
Product name: ”Sport-wash by sno-seal”
Manufacturer: Atsko inc.
Sales point: fjällsport, Gothenburg
Price: 99 SEK
Type: liquid detergent

Dosage
Volume: 532 ml
Amount recommended per wash load: 39,5 ml per wash load
Price per wash load: 7,35 SEK

Notes
Claims to: Restore breathability, wicking, insulation and water-repellence, appearance, hand, elasticity and rapic drying. Leaves no residue, odors, uv brighteners or enzymes.

Contains biological degradable vegetable surfactants made from coconut (Atsko (n.d.))

Ingredients:
Free from bleach, phosphates, softeners and perfumes.
Datasheet Laundry Detergent 5

**Specification**
Product name: “Techwash”
Manufacturer: Nikwax
Sales point:
Price: 120 SEK, friluftsfabriken, Borås, 100 SEK HellyHansen, Gothenburg
Type: liquid detergent

**Dosage**
Volume: 300 ml
Amount recommended per wash load: 100 ml for 2 garments in soft water
price per kg of laundry: 300/100 = 3 washloads, 33,33 SEK per washload, 16,67 SEK per garment

**Notes**
Washing guide: Remove all detergent from detergent dispenser, Place a maximum of 2 garments in the washing machine, Add 100ml of Tech Wash, wash in warm synthetic cycle.

claims to ”restore breathability and waterrepellency

**Environmental claims**
Nikwax Tech Wash® is environmentally friendly; it is non-hazardous, biodegradable and waterbased. Palm oil is not used (Nikwax (n.d.))

**Ingredients:**
Contains:
less than 5% EDTA, polycarboxylates. 15-30% soap
Datasheet Laundry Detergent 6

**Specification**
Product name: ”Pro wash”
Manufacturer: Fibertec
Sales point: Femmans sport, Gothenburg
Price: 119 SEK
Type: liquid detergent

**Dosage**
Volume: 250 ml
Amount recommended per wash load: 25 ml per load in soft water
price per kg of laundry: 250/25 = 10 washloads, 11.9 SEK per washload

**Notes**
Claims to ”optimize the breathability of waterproof/breathable fabrics”, does not leave any residues, “unscented” (Fibertec (n.d.))

**Ingredients:**
Contains:
15-30% nonionic tensides
<5% anionic tensides and soap
Methylisothiazolinone, benzisothiazolinone, colorants and perfumes
Specification
Product name: ”30 °C cleaner”
Manufacturer: Grangers
Sales point: http://www.alloutdoor.co.uk/
Price: 200 SEK for cleaner and waterproofer, approx 100 SEK for cleaner
Type: liquid detergent

Dosage
Volume: 300 ml
Amount recommended per wash load: 30 ml per 1 jacket or 2 base or mid layer garments
price per kg of laundry: 300/30 = 10 washloads,
100/10 = 10 SEK per washload, 10 SEK per jacket

Notes
Claims to protect the durable water-repellent finish of all garments and improve
the performance by removing dirt and grime. The product is recommended for
Gore-Tex, eVent and all waterproof breathable clothing.

Claims to eliminate odours, optimise
breathability and maintain water-repellence.
(Grangers (n.d.))

Claims to be “environmentally responsible”
The product is water based
Cleans in 30 degrees which leads to energy
savings. (Grangers (n.d.))

Ingredients:
Detergent based
Contains:
1-5 % Non-ionic surfactants
Datasheet Waterproofing Agent A

**Specifications**
- Product name: Greenguard wash-in
- Manufacturer: Fibertec
- Sales point: Naturkompaniet, by www.naturkompaniet.se
- Price: 179
- Type: Washin waterproofing agent with polyurethane dendrimer active agents

**Dosage**
- Volume: 250 ml
- Amount recommended per garment: 50 ml
- Price per garment: $\frac{250}{50} \times 179/5 = 35,8$ SEK

**Application**
- Program: softener program
- Drying: tumble-dry at 60 °C in 30 minutes
- Shake bottle well, use 50 ml per garment in the softener compartment, rinse in rinsing cycle, activate in tumble dryer in 60 °C for 30 minutes.

**Notes**
The website states that this product is fluorocarbon and fluorine free but the bottle states ”with new eco-friendly C6-fluorine-active agent”. This could be a typographic fault because in both German and French text on the bottle this sentence does not occur.

**Ingredients:**
- No exact information given

**Environmental**
- Does not contain solvents or fluorocarbons.
- Does not create persistent residue upon biodegradation
Datasheet Waterproofing Agent B

Specifications
Product name: Blue Guard Wash-in
Manufacturer: Fibertec
Sales point: Femmans sport, Gothenburg
Price: 219 kr
Type: Washin waterproofing agent with c6-fluorine-active agent

Dosage
Volume: 250 ml
Amount recommended per garment: 50 ml
price per garment: 250/50 = 5 219/5 = 43,8

Application
program: softener program
Drying: tumble-dryer 30 minutes in 60 °C or iron
Shake bottle well, use 50 ml per garment in in softener compartment, rinse in rinsing cycle, activate in tumble-dryer in 60 °C for 30 minutes.
Datasheet Waterproofing Agent C

Specifications
Product name: TX.direct wash-in
Manufacturer: Nikwax
Sales point: Femmans sport, Gothenburg
Price: 159
Type: Wash-in waterproofing agent with water-repellent elastomer based on ethylene vinyl acetate.

Dosage
Volume: 300 ml
Amount recommended per garment: 100 ml
price per garment: 300/100 = 3 159/3 = 53 SEK

Application
program: gentle washing cycle
drying: Drip dry or tumble-dry on low heat

Remove residue from the detergent compartment, place the garment in the washing machine, use 2 full bottle caps (100 ml) per garment in the detergent compartment, wash in 30 ºC gentle wash with low spin. Tumble-dry on low heat.

Notes
Always use Nikwax Techwash to maintain the water-repellent results, do not use regular washing detergents. (Nikwax (n.d.))

Ingredients:
water >50 %
acetic acid 2-5 %
zirconium acetate 1-2 %
Datasheet Waterproofing Agent D

Specifications
Product name: 30 °C proofer
Manufacturer: Grangers
Sales point: www.alloutdoor.co.uk
Price: 200 SEK for cleaner and waterproofer, approx 100 SEK each
Type: Wash-in waterproofing agent with C6-fluorine agent

Dosage
Volume: 300 ml
Amount recommended per garment: 100 ml, 150 ml for 2 garments
Price per garment: 300/75 = 4 100/4 = 25 SEK

Application
program: washing program
drying: tumble-dry on medium setting

Shake bottle well, use one bottle cap (100 ml) in the detergent compartment, wash in 30 °C, tumble-dry in medium temperature
Besöksadress: Bryggaregatan 17 • Postadress: 501 90 Borås • Hemsida: www.textilhogskolan.se