

Gore-tex: High time for alternatives

Gore-tex, although generally praised as an indispensable component of outdoor garments, forms a threat for our environment and ourselves. This dirty side of Gore-tex (teflon) and similar membranes still seems to be largely unknown among the public, including outdoor fanatics. Therefore, in the first paragraphs I will explain what exactly the problem is, or why it would be better to avoid buying the products in question. After that, we will see that there is no reason to panic: banning Gore-tex in outdoor equipment does not have to be a step backwards at all. To the contrary, in many conditions the alternatives will even perform better.

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July 5, 2009

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An introduction to waterproof clothing

Imagine a rain jacket made from a big plastic bag. It could be perfectly waterproof, but it would not allow any sweat to vapour out. The jacket would not 'breathe', and that could be a reason why waterproof clothes made from plastic are not very popular. Certain synthetic membranes have brought a solution: they are perforated with microscopic pores that allow vapour to pass, but not liquid water: sweat can evaporate out, but rain cannot come in. Most popular among membranes is probably Gore-tex. It is in fact a large molecule (polymer) called polytetrafluorethylene (PTFE). Although being dressed in a membrane might work for a while, these membranes are vulnerable and would tear or get damaged easily. Therefore, producers of outdoor clothing protect the membrane with some layers of synthetic fabric. That's why you can't easily see the membrane in clothes with a PTFE or other membrane. What you see on the outside is often nylon. At the inside, the membrane is usually protected with another lining.

Both PTFE and PFOA belong to a group of chemicals called *fluorocarbons*. More generally, they are organohalogen compounds, just like the pesticide DDT, PCBs and brominated flame retardants.

Although no rain water can pass through the membrane, the water can still soak the outer layer of the clothing. Once soaked, the fabric will not allow vapour to pass any longer ('breath'). Although this outer fabric cannot be made really waterproof, it can be made water repellent, meaning that it will take a while before the fabric becomes wet. To make the outer fabric water repellent (often referred to as the Durable Water Repellent treatment), usually the chemical perfluorooctanoic acid (PFOA) is used.

You might never have heard about PTFE or PFOA, but you probably have been using it. PTFE is known under the market name 'teflon', and is used in scores of applications, such as frying pans, joint



Illustration 1: Other applications than membranes for outdoor clothes that involve PTFE are frying pans, pizza delivery boxes, microwave popcorn bags and bike chain lubricants.

prostheses and bike chain lubricants. PFOA can be found in many sprays for making textile water repellent. PFOA is also a compound necessary for producing PTFE. No PTFE without PFOA.



Illustration 2: Two recent scientific studies showed that babies from mothers with higher blood concentrations of PFOA have on average lower birth weight.

If not heated, PTFE is chemically inert and non-toxic. Unfortunately, PFOA is needed to make PTFE. Like for many other organohalogens such as DDT, PCBs and brominated flame retardants, there is no known natural process that breaks down PFOA ^[1]. Being produced since the 1940s ^[2], PFOA can nowadays be found on all continents, in animals from albatrosses to polar bears and humans ^[3].

In animal studies, PFOA has been shown to cause among other things liver cancer, developmental problems, endocrine disruption and neonatal mortality ^[3]. In occupationally exposed humans biological effects have been demonstrated, such as increased incidence in

bladder and kidney cancer, higher mortality rates for different types of cancer and diabetes, and changes in levels of the thyroid hormone triiodothyronine ^[4]. But also lower concentrations, such as found in the general population, cannot be considered safe. Although one study could not confirm this ^[5], two much larger studies on humans found an inverse correlation between blood serum levels of PFOA and birth weight ^[6,7]. Moreover a recent study from Denmark showed that levels of PFOA currently found in the general population are high enough to increase infertility with 60 to 154% ^[8]. To maintain that more evidence and hard prove is necessary before taking measures for reducing production of hazardous chemicals is a generally used tactic of big companies such as DuPont and 3M. Millions of dollars are spent to consultancy companies such as Exponent, Inc. that are specialized in defending harmful products, such as tobacco and asbestos in the past ^[9]. However, with the evidence available at this time and respecting the precautionary principle, no scientific panel is needed to conclude that it is high time to drastically reduce the production of PFOA.

Actually, we don't need teflon

In a short online essay, Elizabeth Sanberg finds herself in a dilemma when buying outdoor clothes: choosing for the environment or choosing for own convenience ^[10]. Although it is appreciable that the author draws attention to the problems with Gore-tex, I hope to convince the reader that is no need for choosing between environmentally friendly and comfortable.

I will discuss two alternatives for teflon membranes. The first one is in my opinion often the best one, and consists of using clothes without membranes. This is especially useful for boots and in conditions of temperatures below zero. The second option is simply using another kind of membrane. This is a really easy option, but leaves the consumer with all the disadvantages that also come with teflon membranes, apart, in some cases, from the environmental harm.

Alternative one: Better without membrane!

Although one can easily think of conditions where a waterproof membrane is highly appreciable, people often forget that in many more kinds of weather the membrane does more bad than good. I will illustrate this for boots and jackets.

Boots

Let's start with leather hiking boots. The basic problem is simple, and involves the trade-off between treating leather to be waterproof versus breathable. In my experience, no wax or silicone exists that can

Of course, synthetic materials do not 'breathe' such as living organisms do. In spoken language, however, the term 'breathability' refers to the capacity of materials to let air and vapour pass through.

at the same time impregnate the leather to be waterproof for longer than a couple of hours and at the same time leave it very breathable. If you expect dry weather, it is best to put some lighter wax that keeps the leather breathable, and hope that you don't encounter long rain showers or deep water puddles. If

you're going to stay in a wet climate, it is better to give in on breathability, and treat the boot with a heavier wax that will keep the leather dry for longer. Taking two extremes, we have at one hand the leather with high breathability and little resistance to water, and on the other hand leather which almost doesn't allow any vapour to pass, but which will remain dry after being immersed in water for many hours or days. Note that the lighter the leather is treated (or the more breathable), the longer it will take for the leather to dry once it got wet. And wet leather will not 'breathe' at all.

Now add a membrane to the picture. The breathing capacity of a PTFE membrane is better than that of a plastic bag, but not far as good as that of lightly treated leather. To keep it short and simple: no matter how the leather is treated, a membrane will in all cases significantly decrease the breathability of the boot. Illustration 3 shows the combined effect of a membrane and the leather on breathability of the whole boot, for different degrees of waterproofness of the leather. Although exact values depend on both the membrane and the leather, it can be assumed that the breathability of a membrane would be somewhat lower than that of very breathable leather. Of most interest are the very left side of the graph, showing boots with high breathability for in warmer and dryer conditions, and the very right side of the graph, representing boots with good waterproofing and low breathability. As you can see, adding a membrane to well breathable leather reduces breathability of the leather and membrane combined (overall breathability) really a lot. For the more waterproof boots, a membrane does not reduce breathability so much. On the other hand, the leather is so waterproof that the membrane would be completely superfluous.

For all kinds of leather, a membrane increases the drying time of a soaked boot a lot. And last but not least, on points where the leather experiences a lot of friction or bending, the membrane will often tear and leak long before the rest of the boot is at the end of its life. A boot with a broken membrane will have the lower waterproofness of a boot without membrane, and the lower breathability of a boot with membrane.

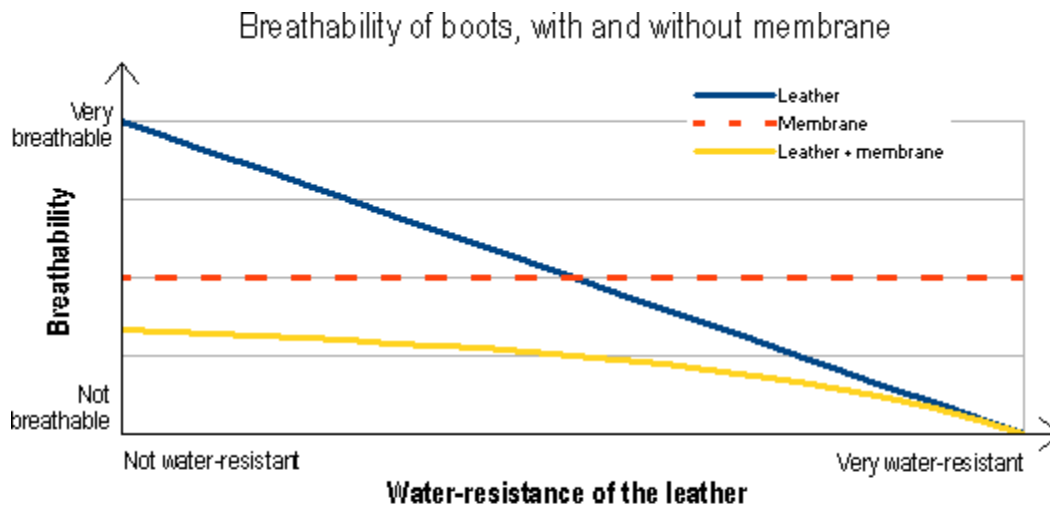


Illustration 3: This figure illustrates how adding a membrane to a boot drastically reduces its overall breathing capacity, especially if the leather is very breathable. The blue line indicates breathability of the boot without membrane, which is inversely correlated to waterproofness. The orange dashed line indicates breathability of the membrane (constant). The yellow curve indicates total breathability of the boot with leather and membrane combined. For calculations of the combined breathability of leather and membrane, see [11].

Jackets

As for leather, any jacket will lose a significant portion of its breathing capacity by adding a membrane to it. Especially when you are walking in warm weather or uphill, there won't be any membrane that can cope with all the sweat. At the other end of the temperature spectrum, membranes become completely useless in conditions colder than a few degrees minus, since the air is usually dry and rain is not an issue. Any wind-proof outer layer will do the job here, and probably perform better than membrane-lined garments concerning breathability. In intermediate conditions however, it can't be denied that membranes have some merits, especially in relatively dry weather with rain showers now and then. However, because of the heavy environmental and health impact of PFOA, alternatives for PTFE membranes should be looked for.

Although both felt (the oldest fabric known to humankind) and different 'soft shells' (synthetic fabrics with properties in between fleece and waterproof garments) have high breathability and can withstand water for a long time, neither of them are satisfying under long-lasting rains. Fortunately, good alternatives with physical properties comparable to PTFE (or even better) are on the market already! And for sure you even know the names of some. It's time to explore alternative two.

Alternative two: Use another membrane

Most outdoor brands, whether they also sell Gore-tex or not, have their own brand of waterproof membrane. For example the North Face (USA) markets technical clothing with HyVent. Fjällräven (Sweden) proudly presents Hydratic and Haglöfs (Sweden) features Haglöfs Proof. Jack Wolfskin from Germany uses Texapore and Regatta from the UK has Isotex. Are these the perfectly environmentally friendly alternative to Gore-tex/PTFE? After interviewing some of those companies on the phone, the following became obvious. Most membranes (although not Gore-tex, eVent and Sympatex) are actually made of polyurethane (PU). The 'building blocks' (or monomers) of PU, isocyanates, are not innocent for living organisms, but on the other hand they don't come close to PFOA as an environmental threat,

and in normal conditions the finished product (PU) does not pose any risks for health. When it comes to the quality of the product, it cannot merely be stated that PU is good or bad. Just as for PTFE membranes, whether the product will be waterproof and have a long life expectancy or not depends more on other compounds of the garment (such as the seams and other layers in the fabric protecting the membrane) than on the actual membrane. PU is also more versatile than PTFE, in the sense that it for example also can be used as a laminate rather than as a membrane. This makes it possible to make stretchy garments, something not possible with PTFE.

Even though the switch from PTFE to PU is surely a step in the right direction, there is one more thing that should not be forgotten: the Durable Water Repellent treatment, for which most often still PFOA is used. Even though PFOA might be an efficient water repellent, there are good alternatives as well. Nikwax, for example, has a range of environmentally friendly, fluorocarbon-free products to make garments water repellent.

The good news is that some companies have already decided to use neither PTFE nor PFOA in their garments. Only PU membranes are used, and for making the outer layer water repellent other products than PFOA are used. The next paragraphs will help you on the way to find 'green' products.

On the market

Boots

Most brands producing leather boots with PTFE, also produce them without it. Often, those boots are bought by customers that plan trips in slightly warmer climates, and therefore prefer boots that are more breathable. Applying a good waterproofing wax would be necessary if you want to use these boot in more wet conditions. Unfortunately, even boots without membranes will often have lining, something I don't like at all because of the long time it takes to get them dry. **Lundhags**, a Swedish brand, is to my knowledge one of the few brands that make PTFE-free boots that already are very waterproof in the shop and at the same time don't have a lining. The legend goes that they need a couple of years of walking in before they stop giving you blisters. My experience absolutely disagrees with this, but it probably also depends on the shape of your foot. As a plus, on their website Lundhags assures their customers to be concerned about the environment, and to be looking for environmentally friendlier options for their products that still contain fluorocarbons. Undoubtedly there must be more small-scale boot manufacturers who make high-quality waterproof boots without PTFE. If you happen to have experience with any of those, your contribution to this website's forum would be most appreciated.

Jackets and other stuff

At least two outdoor clothing brands deserve a word of praise here. One brand is **Patagonia** from the USA. According to their website, they have stopped using PTFE in their products since fall 2008. Patagonia has launched a garment recycling program to recycle polyester fiber garments, also those from competitors. Patagonia estimates that making a garment from recycled polyester just takes about one fourth of the energy compared to making it from oil. They have begun working on the recycling of nylon garments and they plan also to recycle cotton and wool clothing^[12]. Unfortunately they are still using PFOA for the Durable Water Repellent treatment of their products, declaring that they could not find any alternatives meeting their strict criteria (personal communication). I have no experience or reviews for the PTFE-free waterproof, breathable garments from Patagonia. If you have any, feel free

to post them on the forum!

The second brand is a bit younger and smaller, and makes products of highest quality; it is **Klättermusen** from northern Sweden. Also they have banned PTFE from their products. Although at the moment they still can't exclude that impregnations of some of their outer layers contain PFOA, they are fighting for getting their suppliers to make all material PFOA-free. Klättermusen also has a program to recycle nylon. Recently, they have marked their products with an Eco-index, informing the consumer on the ecological impact of any of their products. As for Patagonia, 1% of their total sales goes to environmental projects. If you have any first-hand experience with their products, be welcome to post it on the forum.

In conclusion

Although many products on the outdoor clothing market are far from environmentally friendly, consumers are not left without options if they prefer buying products with a smaller environmental impact. *'Don't buy a jacket. Unless you really need one'* could be read on the Klättermusen website some time in the past, and heeding this advise would probably do more good than anything else. Don't underestimate your power as an individual customer! Especially owners of smaller shops don't need a huge number of people telling them the same thing before they will consider taking action. If your shop doesn't have the 'green' product that you were looking for, don't be scared to talk with the shop owner. They are the ones that should feel bad about not having more green stuff, not you for preferring it.

It's no more than fair to minimise your impact on nature while enjoying it. But ultimately, the choice is yours.

Acknowledgements

I would like to thank everyone who has contributed to this text by discussions, reviewing, providing information or in any other way. Particularly many thanks to Anieke van Leeuwen for the useful comments and suggestions. I have no personal links with any of the companies named in the text.

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