Understanding the PFC Dilemma

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Textile products that repel water and stains while retaining breathability have traditionally been made possible through one widely-used type of chemistry, perfluorinated chemicals or, PFCs. These chemicals have also been used in many fire retardants, as well as—most famously—in the "non-stick" coatings used to make pots and pans easier to clean. Under this broad chemical label, some types have more recently been recognized as hazardous and have been phased out—while others are widely accepted as being safe.

However, the apparel and textile industry has seen more and more "PFC-Free" labels appearing on press releases and product documentation. There are a number of reasons behind this movement. To deliver the modern performance capabilities expected by consumers, brands and chemical companies have been working on new and innovative solutions, rethinking textile and apparel design, and finding new approaches to this chemistry.

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Why PFCs?

To understand the full picture, it's important to look at the chemical designations and background behind the types of PFC chemicals. According to the US Environmental Protection Agency (EPA), there are two main types of PFCs, which are per- or polyfluoroalkyl substances (PFASs). They are perfluoroalkyl carboxylic acids (PFCAs) that have 8 carbon atoms in their molecular chains, aka C8s, and perfluoroalkane sulfonates (PFSAs) that have 6 carbon atoms in their chains, aka C6s.

The type that has raised the most concern in the apparel industry are the PFCA's, or C8s. For the last 20-25 years, C8s were used for durable water repellent (DWR) finishes and stain repellents on many textile products. In the case of many of these types of finishes, the chemical perfluorooctanoic acid (PFOA) was created as an unintended byproduct of the finishing process. PFOA persists in the environment and, as it doesn't break down from sun, water, or air exposure, it bio accumulates.

The Popularity of PFC Coatings

Why are these types of coatings popular? Because, as Woody Blackford, VP Design and Innovation at Columbia Sportswear remarks, "water loves to get in between the spaces in textiles." Textiles are what people wear on a day-to-day basis, "either for comfort or because it's the law [that people have to wear clothes]," he says, only half jokingly. Fluorinated coatings have traditionally been used in textiles because of their unique ability to repel water and dirt from a substrate that inherently attracts it—all the while keeping that substrate breathable. The enhanced performance capabilities that these coating imbue mean greater value and comfort for consumers.

Many recognize that the 'old-school' styles of rubber raincoats are great at repelling rain, but also great at retaining the moisture inside of them. So, when moisture gets trapped inside of an article of impermeable clothing, like a rubberized jacket or boots, wet and cold conditions can actually be created *inside* of the clothing.

Being cold and wet neither bodes well for human comfort, nor does it fit with Columbia Sportswear's mission to keep people protected while they are outdoors. This problem with old-fashioned impermeable clothing is one of the reasons that Gore-Tex was such a breakthrough material in the 1970s, and why Columbia incorporated Gore-Tex into their


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products. Gore-Tex is a breathable membrane that is essentially sandwiched between two layers of fabric. Moisture is wicked from the layer of fabric on the inside of the garment through the membrane to the layer of fabric on the outside of the garment, where it evaporates. One of the essential elements to this system was the fluorinated DWR coating on the outer layer to repel water and, "there is often PFC in the membrane as well," Blackford explains.

PFOA Stewardship

The EPA states that long-chain PFCs, in general, take a long time to break down and have been shown to cause developmental delays and undesirable effects on laboratory animals that have been exposed to them. Due to their persistence, and widespread use in many industries, these manmade chemicals are now found across the planet, in soils, people, and animals. To address this issue, in 2006 the EPA created the 2010/2015 PFOA Stewardship Program and invited eight major chemical companies to commit to removing 95% of PFOA from their emissions and products by 2010 and to completely eliminate them by 2015.

Here we all are and it's 2017, so what's happened in the meantime? One of the companies involved in the PFOA Stewardship Program, Huntsman, moved well ahead of the schedule to stop producing the C8 chemistry before the program's target date, says Craig White, Global Marketing Director, Brand & Retail Marketing at Huntsman International LLC.

Huntsman now offers C6 fluorinated finishes and coatings and has created alliances within the industry to develop fluorine-free, or non-FC, finishes for textile products. High IQ Repel is the brand name of their non-FC textile finish. White remarks that one of the reasons that C6 is still being widely used is that the current, non-FC finishes don't provide the level of oil repellency required for some applications.

Another of the companies involved in the program was DuPont, one of the grandfathers, if you will, of PFCs with their Teflon brand of coatings (discovered circa 1938), and their finishes (discovered in the 1960s), which once used the C8 chemistry. About a year and a half ago, the Teflon brand was separated from DuPont and is now managed through a new company called Chemours, according to Product Specialist, Vicky Helinski. Chemours now only creates fluorinated finishes based on C6 chemistry and also have a new non-FC product on the market. This new product, branded as Teflon EcoElite finish for final consumers, is 60% plant-based, recognized as a USDA bio-based product, and is bluesign approved. It can achieve an 80 spray rating after 20 washes or a 90 spray rating after 10 washes, and has shown an 80 spray rating performance out to 30 washes, which is equivalent to fluorinated coatings.

One of the other benefits of Teflon EcoElite finish, according to Helinski, is that it doesn't impact color or impact airflow through fabric. It is also suitable for synthetics or natural fabrics, whether they are made with spun or filament yarns, or a combination of the two.

As with many newly-developed products, the non-FC chemistry was initially more expensive than the fluorinated C6 finishes, so Huntsman has

been working toward achieving total cost neutrality between the two options. "So that, in the cost-competitive apparel industry, choosing a non-FC finish over a fluorinated C6 one isn't one based on cost," says White.

Today, fluorinated C6 finishes are widely used by some of the most recognizable sustainability stewarding outdoor industry brands because of their proven and enduring performance capabilities. They repel water from gear, such as outerwear and tents, in harsh wet and cold conditions by allowing water to roll off of the material surface and dirt to be more easily wiped off of it versus soaking into it. However, as these are surface coatings, they do wear off and degrade over time through washing, regular wear, and abrasion, and must be periodically reapplied using aftermarket products or, in some cases, reactivated.

Opportunity for Innovation

It seems that many in the industry are seizing the opportunity to explore the possibilities of new chemical compositions and polymer configurations. Companies are, as White puts it, "Investing where we see opportunities in the market and industry movement." Part of the "next phase in Huntsman's evolution is to move away from more synthetic- or oil-based materials and move toward more renewable bio-based chemistry."

A number of industry groups such as the Zero Discharge of Hazardous Chemicals group (ZDHC), the Outdoor Industry Association (OIA), and the bluesign company are trying to make product impacts easier to understand both from a supply chain and product development point of view. The Sustainable Apparel Coalition recently released a new module, the Higg Index Design and Development Module, to enable designers to make more sustainable choices early in the development process. They point out that product designers and developers have the greatest potential to minimize environmental impact, starting from their initial concepts and choices.

Product Design Without PFCs

Blackford spoke about Columbia's journey to create their new OutDry Extreme ECO jacket which is waterproof, breathable, and inherently PFC-free because of the design. As their in-house innovation and research team developed several new approaches to breathables over the last two decades, they were hindered by the same conventional issue that, "traditional membrane systems hadn't changed."

The industry standard was still a fairly fragile membrane sandwiched between two layers of permeable textile. "We needed a new arrangement, so we decided to put the membrane on the outside of the jacket," said Blackford, which eliminated the need for an exterior fabric finish altogether. But to achieve this design breakthrough required some textile engineering and a shift in thinking. The result is an outer layer with a micro porous waterproof membrane, which is then covered with a discontinuous diamond grid made of a highly abrasion-resistant polymer. This gives the jacket greater durability against abrasions in the outdoors. The slick, naturally-repellent surface also reduces the need to wash the jacket as often. In developing the jacket, the design team took their eco mission a step further by making the jacket liner out of recycled polyester, and left the jacket undyed—further reducing the footprint.

On a similar note, Helinski stated that Chemours developed its non-FC Teflon Eco Elite, "to be plant-based by design, to move away from fossil fuel-dependent chemistry and be more sustainable." She says the plant components that they use are a trade secret and that they actually could be different, based on where in the world they're sourced. This is another interesting aspect to consider about the very complex and very global supply chain that we depend on in the apparel and textile industry.

Reexamining Conventions

What is ahead of us as an industry? Blackford says, "We are going to have to think about reexamining every convention that we apply and understand today around textiles. We are capable of so many things and we need to accelerate how we test and measure."

With textile and apparel companies working together to rethink how their products add value, improve consumers' lives, and reduce environmental impact, it is a very positive outlook indeed.

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