Interview with Phil Patterson, Private consultant, Colour Connections, (UK)

- Wide ranging expertise in the textile industry gained from a career that has spanned research, manufacturing and retail; fibres, fabrics and garments; legislation, environmental compliance, standardization and innovation.
- Phil was a founder member of the multi-brand Afirm group, was Chairman of the RITE group which aims to reduce the impact of textiles on the environment
- Projects for World Bank amongst others.

Background Questions:

PFCs are a large group of chemicals. For what type of applications are these chemicals used, and where?

Multiple uses as they are also in polymerized form – used as surfactants, as refrigerants, repellent/non-stick surfaces. The most high profile uses are those such as non-stick and DWR's that carry common brand names e.g. Teflon or Gore-tex.

How are per- and polyfluorinated chemicals (PFCs) assessed for potential hazard for human health and the environment?

There are multiple studies using many different methods and approaches,

What is known about the issues associated with 'long-chain PFCs' and 'short-chain PFCs'?

Such a broad question is in danger of eliciting an answer that treats all PFCs as having the same risk factors. PFCs are a large group of chemicals and each individual chemical will have a different profile.

The perceived wisdom is that long chain PFCs are more problematic than short chain PFCs, but that is largely down to long chain PFCs being less biodegradable and more bioaccumulative. However, if you consider the dose/exposure of long chain PFCs relative to NOAEL's in certain end uses there may be a case to say they could be less harmful than exposure to the breakdown products of short chain PFCs – typically short chain PFCs have to be used in higher quantities than long chain PFCs to get the same effects on certain end uses.

There has to be a sensible discussion on whether certain reactions can (theoretically) happen or do (actually) happen when looking at degradation of certain less harmful PFCs to certain more harmful PFCs.

What is the proportion of PFCs used in textiles relative to the quantity of PFCs used globally across all industries (including electronics, plastics etc.)? Is it known what fraction of that is used specifically in the outdoor industry?

The answer to this should be elicited from the PFC manufacturers who have reliable data on sales. The information in reports with an agenda to stop the use of PFCs in certain end uses cannot be trusted.

Given that there exists such a huge variety and quantity of PFCs in different industrial applications, does science suggest a 'safe' way of using PFCs

The concept of release/exposure and NOAEL's should be used at all stages from manufacture to end of life and low biodegradation and bioaccumulation must be factored in. It is likely that science will suggest there are some end uses where it is wise to use alternatives and others where ongoing use can continue. For example, the use of PFCs to impart non-stick performance to food contact items would logically be a higher priority for substitution than end use where exposure is less likely.

In what ways do PFCs get into the environment and are distributed? Are there effective measures to minimize PFC emissions?

Air, water [manufacture/application/consumer use and laundry]. Disposal/landfill/incineration of products incorporating PFCs. This is not well profiled and fully understood and there are ongoing studies

There are ways to minimize PFC emissions but is the level low enough? E.g. DWR Formulations with 'loose' by-products can be purified by manufacturers to prevent losses during application

Using the most effective type of PFC from a performance end/use perspective means less is manufactured, used and put into the environment compared to using less effective PFCs – again the need to consider specific chemical species and dose/exposure is important

With respect to DWR's there needs to be consideration of what is worse…..a very small amount of stable PFOA associated with C8 or larger amounts of less stable/more biodegradable PFHA associated with C6?

What is the detection and reporting limit for PFCs and similar substances in commercial laboratory tests of products? What about water, snow and other types of samples? Are there reliable tests for all known, resp. relevant, substances?

The whole testing debate is coloured by the almost universal use of the wrong terminology – the phrase 'limit of detection' is routinely [wrongly] applied to the 'limit of quantification'.

We have to consider limits of detection (the limit above which someone can say a specific chemical is definitely there) and limits of quantification (the amount above which someone can say a specific chemical is definitely there at a specific concentration)

For legal judgments then you have to work to the limit of quantification.

For detection of manmade chemicals in areas of the world where no such chemicals have ever been deliberately used the anything above the limit of detection is potentially significant in terms of highlighting mobility of chemicals.

Statistical analysis of samples and blanks is critical because test methods are now so sensitive they can detect ppq (parts per quadrillion) of some chemicals. At these levels contamination from laboratory staff, equipment and reference samples can be significant.

Another critical issue here is what happens to laboratory waste – we could reach a situation where the deliberate use of PFOA and other PFCs in laboratories as reference samples exceeds the unintentional use of the PFOA present in trace amounts in certain products.

What concentration of PFCs and related substances can we habitually find in the environment these days? How hazardous are such quantities from a scientific point of view?

This is a question for experts in the field.

The most recent report by Greenpeace indicated that PFCs were present but at very low levels – for the first time Greenpeace acknowledged the presence of multiple sources of PFCs rather than just the use of DWR's on textiles.

How hazardous are such quantities……..?? We need to be very careful to talk in terms of hazard, dose/expose and risk. The reported levels pose almost no risk but it makes good sense to monitor levels to ensure they are not increasing. It is also important to consider bioaccumulation and degradation of PFCs when judging harmfulness of any species.

PFC concentration, air and water pollution are typically measured in milligrams or nanograms. Can you illustrate how the PFC amounts measured in environmental samples compare to what we know these days about the order of magnitude of e.g. air pollution? How big is 'big' in this context, and what means 'just a little bit'?

The concept of dose/exposure is rarely applied. There is also very little attention paid to the units – any number above zero is used to create alarm by some reporters. It is worth considering that 1 ppm is 1 second in 11 days, 1 ppb is 1 second in 32 years and 1 ppt is 1 second in 32,000 years.

It would appear that workers exposed to high levels of some PFCs have suffered significant health issues and it appears that historically manufacturing facilities have not managed leakages and discharges as well as we may have expected so neighbours could have also been affected…… but that should not necessarily be extrapolated to assume that anyone exposed to tiny quantities of PFCs are at risk. Workers exposed to high levels of radiation typically get radiation sickness and cancers but everyone on earth is exposed to radiation on an ongoing basis – largely without harm. Formaldehyde is classified as a carcinogen and it also present, naturally, in every living cell.

The amount of PFCs in environmental surveys is very much in the 'not very much at all' category but there is a good argument to say it should not be there and it would be better if it wasn't there.

Is there a way to ascertain where the PFC traces found in the environment originally come from? Can we e.g. trace them back to a specific industry, such as electronics, textiles etc.,

This is one for the PFC experts and it needs a degree of honesty regarding by-products present at the point of manufacture and also an honest appraisal of PFCs degradation and what is actually formed from what.

Outdoor / textile related Questions:

PFCs (spec. a substance called PTFE) are also used in fabric membranes of outdoor products. How 'hazardous' are the PFCs if they are inherent in membranes?

The use of PFOA in the manufacture of PTFE and releases of PFOA from manufacturing facilities was the catalyst for the focus on PFCs. PTFE itself is generally regarded as inert and safe but it can contain minute traces of PFOA. PTFE can degrade with extreme heat generating species that are lethal to birds.

PFC-free alternatives are supposedly performing less good than PFC-containing DWR finishes. What are the issues, and what are the reasons? Where is research at with regards to solving these challenges?

The best repellent finish for textiles is based on a C8 fluorotelomer. It provides a lower surface energy than short chain alternatives and therefore repels oil, solvents and water. Short chain alternatives only really repel water. There is a sort of insurance buffer with C8's in that if they become contaminated with anything like detergent residues (anything that is washed or cleaned is guaranteed to pick up residues) they will still repel water. Short chain alternatives need more chemical to be applied to get comparable water repellency to C8 and then the performance drops off relatively quickly and water-repellency is lost – this generally results in the purchase of a new product and all the attendant environmental damage caused during its manufacture.

Fluorocarbon free alternatives are even worse than short chain FC's in terms of repellency. The challenge is that the repellency is a function of the electronegativity of Fluorine and the strength of F-C bonds which are the second strongest bond in chemistry after Si-F. Looking for alternatives as good as C8 is a bit like looking for light that's a bit slower.

People often cite the lotus leaf for inspiration but have you ever seen a lotus leaf that's been through 50 wash cycles? There may be some merit in nano-technology but the risks of nano-technology are arguably greater than the risks of PFCs.

Does any scientific data exist how PFC-free alternative DWR finishes compare to those containing PFCs with regard to their hazardousness for human health and the environment?

The manufacturers will have to have such data to place them on the market – they will promote the benefits over FC's.

As yet there hasn't been a persistent campaign against the PFC-free alternatives but if studied to the extent that PFOA has been then it is likely that a by-product present at trace levels could be targeted based on the effects of the chemical at higher doses. There is some concern over certain siloxanes which are used in silicones products (most textile finishes are polymers and the concern is over the presence of unreacted monomers). Another popular FC-free approach has been the use of dendrimers – these are highly branched polymers and to date I don't think they have been assessed with the same rigour as PFCs. They can be made of different materials and the risks of the dendrimer species, catalysts, residual starting materials, by-products and contaminants would need to be judged.

One of the biggest issues with a move away from C8's is the unintended consequences of doing so. Alternatives are not as good and need replacing more frequently – what are the impacts of manufacturing replacements? How many dioxins, PAH's and so on go up the chimneys of coal fired power stations? How much global warming? How much water pollution from the dyers/finishers who make them?

From the very outset of the PFC debate it has been clear that moving to less good alternatives – as were doing – will have negative environmental effects. Do those outweigh the removal of small quantities of PFCs? I don't know the answer to that but in my opinion the strict control of PFC emissions would have been preferable to de-facto bans whilst the environmental issues of poor performance and durability were considered.

Do PFC-treated jackets pose a risk to the wearer?

No.

Do DWR treatments on a garment last 'forever'? I.e. do they ever 'fall off' the fabric? Why? What can be done about it?

See answer to Q2. PFCs do require an occasional 'pep-up' via the use of heat to refresh performance. This isn't widely known or advertised but many garments will be discarded because water fails to fully bead up. A quick treatment in a tumble dry will normally restore performance. The time taken for a short chain FC to require a pep-up is much shorter than for a C8.

The best C8 DWR's are referred to a 'durable' rather than permanent and they will slowly wear off or wash off the surface of a fabric over 50 or so washes to a point where repellency is compromised.

FC-free alternatives can be based on silicones, PU's or oils/waxes – these will have similar levels of actual durability (i.e. they will wash off slowly), however they will fail to be repellent long before a C8 DWR.