newsletter

Perfluorocarbons (PFCs)

The economic significance of perfluorocarbons (PFCs) is considerable due to their use in a wide range of industrial products. Since mid-April 2003, the EPA (Environmental Protection Agency) in the USA has been analysing the risk potential inherent in one particular PFC, a substance that has been detected across the world in both the environment and in human blood.

Perfluoro-carbons (PFCs), Uses, Teflon®

Perfluorocarbons (PFCs) are organic compounds whose hydrogen atoms in the carbon network have been replaced completely by fluorine atoms. The best-known of these substances - and the one with the most diverse fields of application - is the plastic, polytetrafluoroethylene (PTFE), better known under its commercial name Teflon®. Discovered in 1938 by DuPont, it is produced by a process of tetrafluoroethylene (TFE) polymerisation. PTFE's main properties are extreme resistance to chemicals, its excellent workability, its resistance to high temperatures (workable range −200°C to 260°C) and its high lubricating quality. PTFE is therefore used in many areas of industry, for example:

- as a lubricating agent and tribological additive
- as a coating substance for the bodywork of vehicles, walls, leather, upholstery, etc.
- in clothing (eg GoreTex®, as a water and stain repellent)
- in the space industry
- in seals, fire-resistant cable insulation
- in chemical-resistant containers
- as a coating substance for household goods (eg pots and pans)
- in medicine: coating of implants to prevent rejection by the body

In 1997, worldwide use of fluorinated polymers amounted to more than 80,000 tons, with an annual growth rate of around 7%. PFCs are not only contained in final products (PTFE), they are also used as intermediate products or as materials in the polymerisation process (eg PFOA as an emulsifier). They are also unwanted by-products of certain processes, eg aluminium manufacture.

Current relevance, PFOA, PFC telomers, Biopersistence, Toxicity

The EPA is now assessing the potential risk of the chemical PFOA (perfluorooctanoic acid, 'C-8') after traces of the substance were found in the blood of a large sample of the population of the U.S., in the animal world, and in the environment on a global scale. One reason for this is that for a good 50 years now, PFOA has been discharged into the environment virtually uncontrolled. What is more, recent studies indicate that other PFC telomers (short-chain fluoropolymers) can biodegrade to PFOA in the environment.

This conclusion is supported by the fact that PFOA has been detected throughout the world (even in the Arctic), even though only a few companies produce or use it.
PFOA is biopersistent, ie it biodegrades very slowly and is thus able to accumulate in the environment. In the troposphere, it has a half-life of more than 2000 years; in the human body, the figure is 3-7 years. It is still not known how this chemical is absorbed into the human body. PFOA accumulates in the liver and is rated a carcinogenic substance for animals by the EPA; in tests on rats, an increased incidence of tumours was detected in the liver, the pancreas, in mammary tissue and in the testicles of the animals. PFOA itself does not display any mutagenic effect; other, as yet unknown processes, are evidently responsible for the formation of tumours. Whether these results are transferable to human beings is not presently known.

Decomposition of perfluoropolymers, Waste disposal

Burning perfluoropolymers (thermal decomposition) produces, besides hydrofluoric acid (HF), a whole raft of PFCs such as TFE (tetrafluoroethylene) or TFA (trifluoric acetic acid). This was demonstrated in a laboratory via the decomposition of PTFE (Ellis *et. al.*, Nature, Vol 412, **2001**, 321). Thus, these substances can enter the atmosphere or the human body when everyday objects such as clothing or glossy paper are disposed of. Many of these substances are a potential health hazard; they are weakly biodegradable and can thus accumulate in the environment. For this reason, they have been given the term, "emerging persistent organic pollutants" or "emerging POPs" for short. Furthermore, some PFCs are known to damage the ozone layer, ie they are rated "greenhouse gases". In this context, other potential sources of PFC exist - the semi-fluorinated organic compounds (HCFCs and CFCs) - which will not be dealt with further here.

Conclusion, Outlook

Perfluorocarbons are of considerable importance to industry due to their special properties. They are used in clothing (GoreTex®) as a water and stain repellent, and in numerous everyday products (Teflon® coating of pots and pans) and in paper processing.
All told, there has been relatively little research into the effects of PFCs on human health and the environment compared with the work conducted in the field of chlorinated or brominated organic compounds (eg CFCs, HCFCs). This is because many PFCs are not seen as being "critical" to the environment. Although PFCs are known to biodegrade slowly, accumulate in the environment, and harm the ozone layer, legislation has yet to set limits for emissions.
The EPA is now assessing the potential risk of the chemical PFOA (perfluorooctanoic acid, 'C-8') after traces of this non-biodegradable substance were found throughout the world in human blood and in the environment. PFOA is actively manufactured and used by industry. However, it is also a by-product of other fluorinated PFC telomers and is produced when PTFE is burned in the waste disposal process.

New studies will lead to a re-assessment of the risk potential posed by PFOA and other PFCs. It is likely, therefore, that certain substances will be subject to legal regulations in the future. These may even extend to finished products.

Information for the underwriter

A relevance for underwriting can stem from the environmental impairment and product liability/product recall lines of business if a causal link can be established between PFCs (eg PFOA, TFA) and impairment to health or to the environment. It is a distinct possibility that legislation will impose limits for some kinds of PFC emissions.

Environmental impairment liability:
The major claims potential here stems from pollution of drinking water, especially where companies manufacturing PFCs are situated close to streams and rivers. For example, local residents in Parkersburg/West Virginia filed a class action against a neighbouring PFOA manufacturer, claiming that their drinking water had been contaminated with PFOA and that the company had withheld information concerning the health hazard posed by the chemical.
Furthermore, legislation (eg White Papers/EU directives) may well soon provide environmental groups with options for filing actions, which will only serve to exacerbate the problem.

Product liability/product recall:
In this field of insurance, both the producer of the primary chemical and the manufacturer of the final product (eg clothing) could be the target of claims, especially if certain substances become subject to legal limits. The industry is already well aware of this problem and has defined standards and adopted measures on a voluntary basis. In 2002 for example, the industry voluntarily ceased the production of the chemical PFOS (perfluorooctanoic sulfonate) for safety reasons as a result of the worldwide spread of this substance and its biopersistence. The behaviour of this chemical is similar to PFOA and can react in the environment to form PFOA .

Replacing PFCs with substances that have similar excellent industrial properties but which are less harmful to the environment will be a difficult feat. However, it is certainly possible for the manufacturing processes to be modified in such a way that certain potentially critical substances are either minimised or eliminated altogether.

We recommend, therefore, that developments in this field be carefully monitored in the future.

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