German Association
of the Automotive Industry

Position

PFAS in Automotive Technologies of the Future

Berlin, July 2021

General context

The German Association of the Automotive Industry (VDA) represents more than 600 companies in the vehicle industry – manufacturers of motor vehicles and their engines, trailers, bodies and containers, and motor vehicle parts and equipment – which produce in Germany. The automotive industry has the highest turnover of any sector in the German economy. In 2019, it generated revenue of over 435 billion euros with a workforce of around 833,000 building approx. 4.7 million passenger cars in Germany – out of more than 16 million cars worldwide. This does not include commercial vehicles (trucks and buses) produced by our member companies. Together we research and produce to bring about the clean, safe, and sustainable mobility of the future.

A large proportion of vehicles is still built in Germany, despite the much more dynamic growth in production in other countries. It is therefore vital to avoid any additional burdens hampering German competitiveness. That includes uncertainties in the regulations, and restrictions on the spectrum of materials required.

Extensive limitation of per- and polyfluoroalkyl substances (PFAS) – a group of around 4,700 different compounds – would have far-reaching impacts on the automotive industry, which are described in this document.

Core message

In the automotive industry's technologies of the future, the use of PFAS will remain essential for achieving the targets of the EU's European Green Deal.

With the responsible use of PFAS in the automotive industry, their release into the environment can be very largely eliminated throughout the entire vehicle lifecycle.

Background to PFAS

Owing to their unique properties, PFAS are used today in a large number of industrial products and consumer goods – often thanks to their high thermal and chemical resistance, their very low surface tension (which renders them both water repellent and oil repellent), and the fact that in polymeric form they are highly resistant to abrasion and wear.

Long-chain PFAS are hazardous owing to their persistence and bioaccumulation. However, they have already been replaced with less hazardous short-chain PFAS.

In its Chemicals Strategy for Sustainability adopted in 2020, the European Commission proposed an extensive package of measures for the general regulation of all PFAS, irrespective of whether their properties are hazardous or non-hazardous.

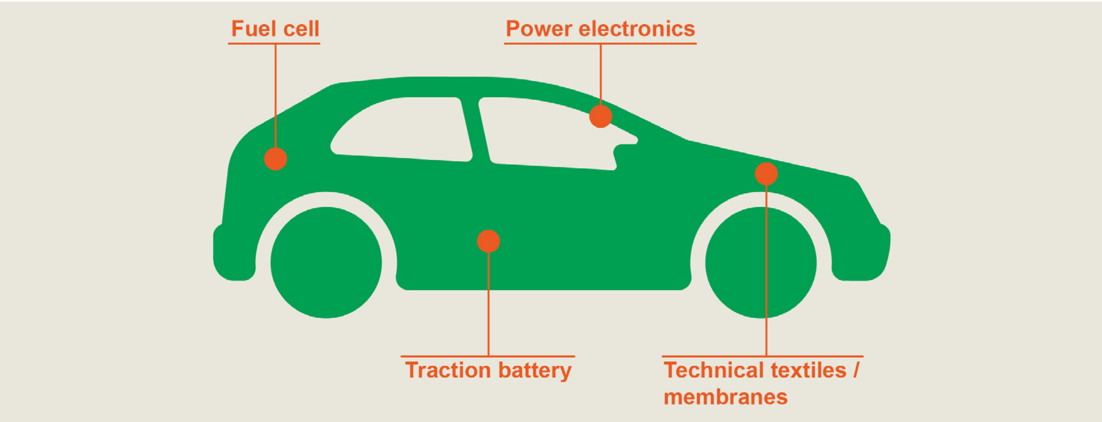
This was intended to ensure that application of PFAS in the EU would be gradually phased out. Exceptions are to be permitted only in the case of essential uses that have still to be defined as the restrictions are drawn up. The policy of limitation to essential uses will in fact also restrict future developments. What is regarded as non-essential today also has no chance at all of being developed as an essential uses at a later date. If the EU wishes to remain a motor for innovation, this type of concept cannot be static in regional or temporal terms.

Use of PFAS in the automotive industry

Vehicles differ from other “consumer products” because of their complexity and longevity. A vehicle consists of around 5,000 to 7,000 parts and a much larger number of sub-components that have to satisfy high standards and quality requirements. These include guaranteed vehicle safety, reliability under large temperature fluctuations, flame retardancy and high durability over the whole lifecycle of 15 to 22 years.

This demands the application of advanced technologies and optimized materials (see figure). PFAS are deployed in key roles because of their special properties. Without PFAS, both existing vehicles and future automotive technologies would be inconceivable. A ban on PFAS would prevent the use of alternative powertrains and thus also achievement of both the European Union’s and Germany’s climate protection goals for the transport sector.

PFAS are necessary for introducing future technologies



PFAS in traction batteries

Traction batteries for motor vehicles must satisfy high standards relating to lifetime, charging speed, high energy density and continuous charging capacity. The materials used in lithium-ion batteries must therefore be carefully selected, ensuring that they are stable over a range of external temperatures and when in contact with high currents/energy levels.

The stability of fluorocarbon compounds makes them indispensable when it comes to fulfilling these demands.

At present, there are two major PFAS applications in modern lithium-ion batteries:

PVDF (polyvinylidenefluoride) is used as a binder for coating the cathode with metal oxides.

PVDF cannot be released into the environment because the batteries are manufactured under clean-room conditions in enclosed systems. Emission of PVDF is also impossible during use, as the cells are encapsulated and sealed. When the cells are due for recycling, they are shredded and the metal oxides are recovered by hydrometallurgical treatment. During the process, PVDF is broken down completely and the resulting fluorine compounds are removed using gas scrubbers.

Other perfluorocarbon compounds such as PTFE (polytetrafluoroethylene; commonly known as Teflon TM) are currently being tested so that in the future, the solvent N-methyl-2-pyrrolidone (NMP), which is known for its reproductive toxicity, will not be needed for the coating.

Fluoroorganic additives in electrolytes for improving the lifetime of battery cells.

The fluorine compounds that are used, such as fluorobenzene and fluoroethylene carbonate (FEC), form a protective layer that prevents the material in the anode from reacting with the electrolyte.

As with PVDF, release into the environment is not possible during normal operation when the battery is used as intended, and is limited to disruptions and accidents. The fluoroorganic additives are also used in enclosed systems during battery cell production, and when the battery is in use they are encapsulated within the cell. They are broken down during recycling, and the resulting fluorine compounds are removed using gas scrubbers.

To increase the future performance of lithium-ion batteries, anodes with a higher silicon content will be used, which will also greatly increase the use of fluorocarbons such as FEC.

PFAS in fuel cells

In the near future, fuel cell technology will also become important in the automotive powertrain mix and for zero-emission driving.

PFAS have many different applications in fuel cells, e.g. PFAS are present in the polymer electrolyte membrane (PEM), the electrodes, the gas diffusion layers, the sealants for gas, water and air passages, and in coolant circuits.

Only certain specific fluorinated ionomers have the technological maturity to be deployed as proton-conducting materials within the very reactive environment inside a fuel cell. As hydrophobic agents and electrochemically stable binders, only fluorinated polymers like PTFE and FEP (fluorinated ethylene propylene) are capable of withstanding the acidic conditions close to the catalyst/membrane in a fuel cell. Sealants and hose materials in the vicinity of the fuel cell must also be very chemically, mechanically and thermally stable – and are therefore made of PTFE, FEP or fluoroelastomers (fluoro rubber, FKM).

Furthermore, deployment in vehicular fuel cells requires that PFAS can also continue to be used in the fuel cell itself and in all other components necessary for the powertrain (e.g. storage cell, electric motor, transmission, drive shaft), and all other vehicle components.

PFAS in power electronics

In power electronics, PFAS are used in diaphragms, seals and case coatings, primarily in the production of liquid crystals and semiconductors, which are essential for electric mobility applications and automated and connected driving.

In the production of semiconductors, short-chain PFAS are used in the central photolithography process because of their high technical functionality and chemical properties. Here, special PFAS-containing formulations are applied to create the structures on the silicon wafers in a series of repeated steps. Here the PFAS are used in closed systems. As they are process chemicals, none of the perfluorinated substances appear in the final product. This prevents release into the environment through the final product. Until now, attempts at substitution with other chemical compounds have not achieved the required properties that perfluorinated substances exhibit.

In addition, owing to their outstanding properties, PFAS are also used as oils in contact systems in safety-critical sensor applications. Here the exceptional ageing resistance and corrosion-reducing effect on metallic contact surfaces, in combination with their high compatibility with other materials (e.g. thermoplastics), make these substances irreplaceable.

PFAS in technical textiles and membranes

Many technical textiles in vehicles need a surface that repels oil, water and dirt, high chemical stability (especially high hydrolysis and acid resistance, plus high thermal resistance and high UV resistance. At the present time, this can only be achieved with coatings containing fluorocarbons. Another advantage is the markedly longer lifetime of the components and parts.

Relevant parts/components include first and foremost nonwovens and membranes both in fuel cells and in batteries (see above), gas filter membranes in air-conditioning systems, engine compartment covers that minimize the fire load, and exhaust treatment systems in automobiles.

PFAS in seals and hoses

Fluorinated polymers – both elastomers and various thermoplastics (principally FKM, FFKM, FVMQ, F-TPV, ETFE and PTFE) – are found in a great variety of applications for sealing and transporting various automotive fluids owing to their unique physical and chemical properties. Because of their high thermal resistance, their high chemical resistance (particularly to lubricants, fuels, exhaust gases and coolants), and their frequently excellent resistance to abrasion and wear, with simultaneous outstanding permeation sealing properties, these materials are irreplaceable today.

Typical applications include seals and gaskets in the vicinity of the engine and the transmission, in fuel and coolant systems, and hoses for fuels and coolants.

Replacing these materials with inadequate alternatives would reduce vehicle lifetimes, increase the rate of damage, and push up emissions during vehicle operation. Emissions would be unavoidable, in particular where more permeable materials come into contact with exhaust and fuels.

As a result of the transition from combustion-engine technology to electric mobility, several kinds of seals and hoses made from fluorinated polymers will no longer be needed. Nonetheless, vehicles with electric drive (batteries or fuel cells) will still require components containing fluoropolymers in the powertrain peripherals, in the rest of the drive train, and in all other components.

Responsible use of PFAS by the automotive industry

Release of PFAS into the environment is very largely ruled out in the applications in the automotive industry and occurs only in the case of disruptions and accidents. During the manufacture of parts, PFAS are deployed in closed systems. When the vehicle is operating they are encapsulated, and during combustion they are broken down into volatile fluorine compounds that are then removed from the exhaust gas, e.g. by gas scrubbers. This avoids any uncontrolled release of PFAS into the environment. This applies to all the listed applications in future technologies.

List of abbreviations

ETFE	Ethylene tetrafluoroethylene copolymer
FEC	Fluoroethylene carbonate
FEP	Fluorinated ethylene propylene
FFKM	Perfluoroelastomers
F-TPV	Thermoplastic fluoroelastomer vulcanizate
FVMQ	Fluorosilicone rubber
FKM	Fluoro rubber/fluoroelastomers
PEM	Proton exchange membrane or polymer electrolyte membrane
PFAS	Per- and polyfluoroalkyl substances
PVDF	Polyvinylidenefluoride
PTFE	Polytetrafluoroethylene; commonly known as Teflon™

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