PTFE FACTS

PFAS stands for per- or polyfluoroalkyl substances. The term PFAS describes a large group of thousands of different chemicals with very different properties. Polytetrafluoroethylene (PTFE) is a member of the fluoropolymer class of per-and polyfluorinated alkyl substances (PFAS).[1]

PTFE is non-toxic and safe for the end user.[2]

PTFE is a very large molecule that is unable to enter the human cell passively due to its size, nor does it have the appropriate chemical or structural properties that would enable it to interact with other biomolecules to actively move into the cell. In addition, PTFE doesn't bind to the cell surface receptors or signal events within the cell. Since PTFE is not subject to passive or active transport and does not bind to the surface receptors necessary for cell signaling, it is not bioavailable.[3] If a molecule cannot get into the cell or bind to the cell, it cannot be toxic. Therefore, PTFE is non-toxic and safe for the end user.[4]

PTFE is an extremely stable molecule and resistant to degradation.

PTFE does not break down to be a source of non-polymer PFAS unless exposed to extremely harsh temperatures or chemicals that would themselves have a negative impact on human life.

A Continuous Use Temperature is the temperature at which a material can be heated and be used for an indefinite amount of time without change in its properties. For PTFE the Continuous Use Temperature is 260°C (500°F). This means a PTFE membrane can be heated and used safely until the polymer itself exceeds a temperature of 260°C. Only if the PTFE is heated above 260°C, could there be the potential for degradants or off-gases.[5]

FIREFIGHTING FACT: NFPA-1971 standard for material used in moisture barriers requires the materials can withstand exposure to 260°C temperatures for 5 minutes.

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[1] Buck RC et al., 2011. Integr Environ Assess Manag 7(4):513-541; OECD (2021), *Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*, OECD Series on Risk Management, No. 61, OECD Publishing, Paris.

[2] Henry et al., 2018, Integr Environ Assess Manag 14 Supplement, pp 327-328; L.L. Radulovic, Z.W. Wojcinski, 2014, Encyclopedia of Toxicology (Third Edition).

[3] Paul Leeson, 26 January 2012, *Drug discovery: Chemical beauty contest*, *Nature 481*, pp 455–456; ECETOC Special Report No. 18, Brussels July 2014, *Information to be considered in a weight-of-evidence-based PBT/vPvB assessment of chemicals (Annex XIII of REACH)*; Ming-Qiang Zhang and Barrie Wilkinson, 2007, *Drug discovery beyond the 'rule-of-five'. Current Opinion in Biotechnology*, pp 18:478–488; Henry et al., 2018, *Integr Environ Assess Manag 14* Supplement, pp 327-328.

[4] Paul Leeson, 26 January 2012, *Drug discovery: Chemical beauty contest*, *Nature 481*, pp 455–456; ECETOC Special Report No. 18, Brussels, July 2014, *Information to be considered in a weight-of-evidence-based PBT/vPvB assessment of chemicals (Annex XIII of REACH)*; Ming-Qiang Zhang and Barrie Wilkinson, *Drug discovery beyond the 'rule-of-five'*, *Current Opinion in Biotechnology* 2007, pp 18:478–488; Henry et al., 2018, *Integr Environ Assess Manag 14* Supplement, pp 327-328; L.L. Radulovic, Z.W. Wojcinski, 2014, *PTFE (Polytetrafluoroethylene; Teflon®) in Encyclopedia of Toxicology (Third Edition)*.

[5] Plastics Industry Association, *Guide to The Safe Handling of Fluoropolymer Resins, 5th Ed.*, https://access.plasticsindustry.org/ItemDetail?iProductCode=BU201&Category=PUBLICATION; Thomas Douglas and Ann W. Harman, November 18, 1964. *Relative Enthalpy of Polytetrafluoroethylene.*

It is only when PTFE is heated to temperatures above 400°C that time/temperature degradation begins to take place.[6] For example, if PTFE is heated to 400°C it would need to maintain that temperature for approximately 25 hours before there was even a 1 percent loss of mass.

FIREFIGHTING FACT: PTFE has been shown to release monomeric TFE, however only at temperatures above 400°C (752°F) and only in non-oxygenated environments. Because combustion requires oxygen, such conditions are not present at a fire scene.[7]

Non-Polymer PFAS

PFOA stands for perfluorooctanoic acid, which is a non-polymer PFAS (perfluoroalkyl substance). Historically, PFOA was used by manufacturers of PTFE fine powder as a polymerization aid to efficiently enable the TFE monomer polymerization reaction to make PTFE. PFOA appeared only as a trace residual in the PTFE raw materials from the polymerization process. Since PFOA has never been a component of the PTFE molecule, PTFE molecules do not degrade into PFOA.

Previously, PFOA residuals could be measured at trace levels in the raw material used to produce PTFE membranes. The PFOA residuals did not affect the base properties of raw materials used by Gore nor the safety and performance of our products. Nearly all the trace residuals were eliminated during our processing of the raw materials into finished products.[8] In alignment with the EPA PFOA Stewardship program, Gore worked closely with its suppliers to remove PFOA from its global fabrics supply chain. This was successfully completed in 2013.[9]

Exposure Assessment re Non-Polymer PFAS

To evaluate potential exposures and potential risks of cancer for firefighters from any traces of PFOA residuals or the replacement chemistries that may remain in our products, exposure assessments were conducted in alignment with EPA approved methodologies. Exposures and risks were calculated using publicly available data and a series of standard equations for multiple potential routes of exposure, including skin contact, hand-to-mouth contact, ingestion of dust, and inhalation of particulates. These exposure assessments determined that even if Gore's moisture barrier product is worn over an entire career of a fire fighter, the highest potential level of non-polymer PFAS (PFOA or replacement chemistries) was well below the EPA levels[10] of exposure that were determined to be safe.

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[6] Plastics Industry Association, *Guide to The Safe Handling of Fluoropolymer Resins, 5th Ed.*, https://access.plasticsindustry.org/ItemDetail?iProductCode=BU201&Category=PUBLICATION; Thomas Douglas and Ann W. Harman, November 18, 1964. *Relative Enthalpy of Polytetrafluoroethylene*; Peter R. Hondred et al., 2013, *Degradation kinetics of polytetrafluoroethylene and poly(ethylene-alt-tetrafluoroethylene)*.

[7] Angela Garcia et al., 2007, *Products obtained in the fuel-rich combustion of PTFE at high temperature*.

[8] Barbara Henry, 20 August 2019, *Exposure Assessment and Cancer Risk Characterization for Firefighters from Non-Polymeric PFAS Residuals in Gore Components Used in Firefighting Gear*.

[9] W. L. Gore & Associates, Inc., 10 January 2014, *Gore Completes Elimination of PFOA from Raw Material of Its Functional Fabrics,* https://www.gore-tex.com/pressroom/press-release/responsibility-sustainability/gore-completes-elimination-of-pfoa-from-raw-material-of-its-functional-fabrics.

[10] United States Environmental Protection Agency, May 2016, *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA), https://www.epa.gov/sites/default/files/2016-05/documents/pfoa_health_advisory_final-plain.pdf*, Section 7.0 pp 44; Plastics Europe Association of Plastics Manufacturers, *Tetrafluoroethylene (TFE): Safe Handling Guidance Available*, https://fluoropolymers.plasticseurope.org/index.php/tfe-safety.