BLUE FOOT
unbreakable membranes ™

PVDF MEMBRANES, PFAS AND THE EU RESTRICTION PROCESS

CUSTOMER INFORMATION ON BLUE FOOT IPC® MEMBRANES FOR WASTEWATER TREATMENT

Summary

The proposed EU restriction on PFAS has understandably raised questions about the future of PVDF membrane technology in water and wastewater treatment.

After reviewing available scientific literature, water-sector position papers, supplier information and Blue Foot's own analytical testing data, Blue Foot Membranes remains confident that PVDF membrane technology continues to be a proven, extensively tested, evidence-based and future-ready solution for water treatment. [watereurope.eu], [Shah et al, 2021], [Améduri, 2025], [Korzeniowski et al, 2022]

1. **PVDF membranes are part of the solution to PFAS contamination**

Membrane technologies are already used by utilities to manage PFAS contamination in water. Water Europe identifies membrane technologies such as reverse osmosis and nanofiltration among the treatment methods used where PFAS removal is required. Water Europe also specifically identifies PVDF membranes for water treatment as a well-studied fluoropolymer of low concern used in water and wastewater management systems. [watereurope.eu].

PVDF is one of the most widely used membrane materials in the water industry and forms part of the infrastructure used to produce drinking water, recycle wastewater and protect environmental water quality. Independent industry sources describe PVDF as the most common membrane material used in water and wastewater filtration and as a cornerstone material in membrane bioreactor (MBR) systems. [Shah et al, 2021], [thembrsite.com], [membraneco...ltancy.com]

In many advanced treatment systems, membranes are combined with technologies such as powdered activated carbon (PAC), granular activated carbon (GAC) or ion exchange. In these treatment trains, activated carbon captures PFAS while membrane systems provide solids separation, treatment stability and process reliability.

PVDF membranes should therefore not be viewed solely through the lens of PFAS regulation. They are also technologies used by water utilities to help manage PFAS contamination and protect public health. [watereurope.eu], [Shah et al, 2021], [thembrsite.com]

2. **PVDF is fundamentally different from the PFAS compounds that originally raised concern**

Scientific literature describes fluoropolymers as high-molecular-weight materials that are insoluble in water, non-mobile, non-bioavailable and non-bioaccumulative. Their behaviour differs fundamentally from low-molecular-weight PFAS compounds such as PFOA and PFOS. [Améduri, 2025]

3. **PVDF is recognised as a Polymer of Low Concern**

Water Europe specifically refers to PVDF membranes as examples of well-studied fluoropolymers of low concern used in water and wastewater management systems. Scientific literature similarly distinguishes fluoropolymers from many other PFAS substances because of their high molecular weight and lack of bioavailability. [watereurope.eu], [Améduri, 2025], [Korzeniowski et al, 2022].

4. **Blue Foot's own testing has not identified PFAS release**

Blue Foot's PFAS testing programme included process water, wastewater, membrane material and long-term membrane-leachate investigations. It included analysis of 42 PFAS compounds and no detected PFAS traces in analysed membrane samples under the reported test methods.

5. Blue Foot verifies the finished membrane, not only the raw material

The IPC® membrane manufacturing process includes an oxidative NaOCl rinsing step. PFAS verification is therefore performed on finished membranes that have already been exposed to an oxidising environment as part of normal production. This provides an additional opportunity to detect PFAS species that could potentially be mobilised under oxidative conditions.

6. Blue Foot uses NSF-61 certified PVDF grades

The PVDF polymer grade used by Blue Foot is certified to NSF/ANSI/CAN 61, one of the most widely recognised health-effects standards for materials and components used in drinking water systems.

Blue Foot's three-layer PFAS control approach

1. Qualified PVDF resin
Blue Foot uses PVDF grades from suppliers that do not use PFAS emulsifiers or fluorosurfactant production agents for the grades used in IPC® membranes.

2. Manufacturing process with oxidative rinsing
IPC® membrane production includes a NaOCl rinsing step as part of the manufacturing process.

3. Finished-product verification
PFAS verification is performed through wastewater monitoring and membrane-leachate testing on finished IPC® membranes after completion of the manufacturing process.

This means Blue Foot qualifies the PVDF source and verifies the finished membrane product under defined test conditions.

7. PVDF membranes have validated end-of-life management pathways

PVDF membranes typically operate for 5–10 years while remaining in continuous contact with water. Blue Foot's testing programme did not identify evidence of PFAS release during manufacturing verification, wastewater monitoring or long-term membrane-leachate testing. In addition, industrial-scale research has demonstrated that PVDF-containing waste can be effectively destroyed in modern hazardous-waste incineration facilities, reporting complete mineralisation of the organic fluorinated content and destruction and removal efficiencies (DREs) of 99.9999% or higher under the reported operating conditions [Corbin et al, 2026]. These findings indicate that validated end-of-life management pathways exist for PVDF-containing membrane products and form an important part of their overall lifecycle assessment.

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1 PVDF Is Fundamentally Different from the PFAS Substances Driving Most Concern

The term PFAS encompasses thousands of substances with very different physical, chemical and toxicological properties. Public concern is primarily associated with low-molecular-weight compounds such as PFOA, PFOS and related substances that can be mobile in the environment.

PVDF is fundamentally different. PVDF is a fluoropolymer, not a low-molecular-weight PFAS chemical.

Scientific literature describes fluoropolymers as:

- High molecular weight
- Insoluble in water
- Non-mobile
- Non-bioavailable
- Non-bioaccumulative
-

Both industry and peer-reviewed literature describe fluoropolymers as possessing environmental and toxicological properties that differ fundamentally from many other PFAS substances. [Améduri, 2025], [Korzeniowski et al, 2022]

The fact that PVDF belongs to the broader fluoropolymer family does not imply that finished PVDF membranes behave like low-molecular-weight PFAS contaminants in water.

2 PVDF as a Polymer of Low Concern

Blue Foot believes that discussions regarding PVDF should be based on actual environmental behaviour rather than broad chemical classifications alone.

Scientific literature has concluded that fluoropolymers satisfy internationally recognised Polymer of Low Concern criteria because of their high molecular weight, insolubility, lack of mobility and lack of bioavailability. [Améduri, 2025], [Korzeniowski et al, 2022].

This distinction is also reflected in the European water sector's position. Water Europe specifically recommends balancing PFAS regulation with the continued use of certain essential technologies based on well-studied fluoropolymers of low concern, including PVDF membranes used for water treatment. [watereurope.eu]

For customers, the key question should not simply be whether a material contains fluorine, but how it behaves in its intended application and whether it poses an environmental or health risk during use.

3 PVDF Membranes Are an Essential Water-Treatment Technology

PVDF membranes are among the most widely used membrane materials in the global water sector.

Peer-reviewed literature identifies PVDF membranes as one of the most commonly used membrane materials for water treatment applications, including drinking water production and wastewater treatment. [Shah et al, 2021]

PVDF membranes are widely applied in:

- Drinking water treatment
- Municipal wastewater treatment
- Industrial wastewater treatment
- Water reuse and recycling
- Membrane bioreactor (MBR) systems
- Ultrafiltration and microfiltration processes

Industry experts describe PVDF as the dominant membrane material in many MBR installations and one of the most important membrane materials used in water treatment infrastructure. [membraneco...ltancy.com], [thembrsite.com]

4 Modern PVDF Manufacturing Has Moved Away from Legacy Fluorosurfactant Chemistry

Historical concerns regarding fluoropolymer manufacture often originated from fluorinated processing aids and surfactants previously used in certain manufacturing routes.

Major fluoropolymer producers have publicly disclosed transitions away from these technologies.

Arkema states that it uses exclusively non-fluorinated surfactants in its global manufacture of PVDF [Arkema-1]. Arkema also reports fluorosurfactant-free production technologies for relevant Kynar® PVDF product families. [Arkema-2], [Arkema-3], [Arkema-4]

Syensqo (formerly part of Solvay) announced expansion of non-fluorosurfactant manufacturing technologies and a transition toward nearly complete fluorosurfactant-free fluoropolymer production. [solvay.com]

Syensqo reports development of fluoropolymer technologies that no longer require fluorosurfactants and states that fluorosurfactants were eliminated from U.S. production in 2021. [syensqo.com]

These developments demonstrate that historical concerns associated with fluorinated processing aids should not automatically be applied to modern PVDF production technologies.

5 Blue Foot Uses PVDF Grades Manufactured Without Fluorosurfactant Production Agents

Blue Foot's PVDF polymer used to manufacture IPC® membranes is sourced from suppliers that do not use fluorosurfactants or PFAS emulsifiers in the production of the grades used by Blue Foot.

Accordingly, Blue Foot's position is that modern PVDF production routes should be assessed based on both documented current production technology and verified finished-product testing, rather than on historical manufacturing methods that are no longer representative of current industry practice.

6 The Importance of Raw Material Selection

When discussing PFAS and PVDF membranes, it is important to distinguish between the finished membrane product and the manufacturing route used to produce the underlying PVDF polymer.

Historically, some PVDF production processes relied on fluorinated surfactants or emulsifiers during polymerisation. These processing aids are fundamentally different from the finished PVDF polymer and have been the focus of much of the environmental concern surrounding fluoropolymer production.

This distinction is important because PVDF membranes manufactured from raw materials originating from different production routes may not exhibit identical environmental profiles.

A recent study reported PFAS occurrence and release in selected commercial hollow-fibre PVDF ultrafiltration membranes collected from the Chinese market. The study highlighted the importance of membrane formulation, production route, ageing behaviour and chemical-cleaning exposure. The findings reinforce the need for qualified raw materials and product-specific verification rather than broad generalisations about PVDF membrane technology. The study therefore supports the importance of understanding both the origin of the PVDF resin and the chemistry used during polymer production and membrane manufacture. [Timing Jiang, 2026]

Blue Foot believes that this study illustrates an important principle:

> **The environmental performance of a PVDF membrane begins with the environmental profile of the PVDF resin from which it is manufactured.**

For this reason, Blue Foot sources PVDF grades that are manufactured without PFAS emulsifiers or fluorosurfactant production agents. Blue Foot's supplier selection philosophy aligns with the broader industry transition toward fluorosurfactant-free fluoropolymer production technologies reported by companies such as Arkema and Syensqo (formerly part of Solvay).

From Blue Foot's perspective, the lesson is not that all PVDF membranes should be viewed identically. Rather, it demonstrates why material sourcing, supplier qualification and manufacturing chemistry are critical factors when assessing the environmental profile of any membrane technology.

Blue Foot believes this principle extends beyond raw material selection alone. **The environmental profile of a membrane must ultimately be demonstrated at the level of the finished product.** For this reason, Blue Foot combines supplier qualification with a manufacturing process that includes oxidative NaOCl rinsing, followed by wastewater monitoring and membrane-leachate verification of IPC® membranes.

Just as water-treatment professionals evaluate membrane performance based on the quality of the raw materials used, environmental assessments should also consider the origin and production route of the underlying polymer.

Accordingly, Blue Foot believes that discussions around PVDF membranes should distinguish between:

- legacy fluoropolymer production routes that utilised fluorinated processing aids,
- modern fluorosurfactant-free PVDF production technologies,
- the finished PVDF polymer,
- and the performance of the final membrane product.

Failure to make these distinctions risks treating fundamentally different materials and manufacturing routes as though they are environmentally equivalent when, in practice, they may not be.

7 Blue Foot's Wastewater Monitoring and Leaching Studies

Blue Foot has performed multiple PFAS investigations covering process water, wastewater and membrane samples. It is important to note that the IPC® membrane manufacturing process itself incorporates an oxidative NaOCl rinsing step. This step is part of normal membrane production and is not added solely for testing purposes. Consequently, PFAS verification is performed on finished IPC® membranes that have already been exposed to an oxidising environment relevant to both manufacturing and subsequent membrane use in water-treatment applications.

This distinction is important because recent scientific literature has reported PFAS release from certain commercial PVDF ultrafiltration membranes following membrane ageing and exposure to oxidising and alkaline cleaning conditions. Blue Foot therefore combines qualified resin sourcing with finished-product verification through wastewater and membrane-leachate testing after completion of the normal manufacturing process, including the NaOCl rinse.

The documented testing programme included:

- Analysis of process water and wastewater streams
- Analysis of 42 PFAS compounds
- Long-term membrane leaching studies
- Independent laboratory investigations by Normec and VITO

Blue Foot's membrane leaching study involved immersing IPC® membrane samples in ultrapure water for approximately ten months prior to analysis.

Reported results include:

- Sum of quantified PFAS below 0.01 µg/L in analysed water samples.
- High-resolution VITO analysis reporting concentrations that were below detection limits.
- No detectable PFAS traces in analysed membrane samples using reported analytical techniques.

Based on the reported results, Blue Foot has not identified evidence of PFAS release from manufacturing wastewater streams or IPC® membrane products under the tested conditions.

Blue Foot therefore does not assess membrane performance solely on the basis of polymer type. The company evaluates the complete chain from resin production route to finished membrane verification.

8 What This Means for the Operational Phase

The operational phase is the part of the membrane lifecycle most relevant to customers.

Blue Foot's testing programme found no evidence of PFAS release from IPC® membrane products under the reported test conditions. Importantly, this testing is performed on finished membranes after completion of a manufacturing process that includes an oxidative NaOCl rinsing step. This means the tested IPC® membranes have already been exposed to an oxidising environment relevant to one of the release mechanisms identified in recent PVDF membrane-ageing studies.

This observation is consistent with independent membrane-industry commentary stating that significant PFAS shedding from PVDF membranes during actual operation has not been demonstrated. [thembrsite.com]

Blue Foot therefore distinguishes clearly between:

- Historical fluoropolymer production issues
- Modern PVDF membrane manufacture
- Actual membrane operation in water-treatment systems
- Responsible end-of-life management

The available evidence relevant to Blue Foot products indicates no measurable PFAS release during the tested manufacturing and membrane-water-contact conditions.

9 End-of-Life Management of PVDF Membranes

A meaningful assessment of any membrane material should consider its entire lifecycle, including end-of-life management. While PFAS discussions often focus on production and use-phase considerations, overall environmental performance should also account for service life, replacement frequency, and the treatment of spent membrane materials.

The Fluoropolymers Product Group has reviewed end-of-life routes for fluoropolymers in Europe. Its report identifies hazardous-waste incineration as the largest end-of-life pathway, accounting for approximately 50% of the fluoropolymer waste stream. Other reported pathways include municipal waste-to-energy combustion at 22%, landfilling at 13%, thermal destruction during metal recycling at 11.5%, and material recycling at 3.4%. The report also states that fluoropolymers represent less than 0.01 wt% of the total European waste stream. This places the fluoropolymer waste stream in perspective, although actual emissions depend on waste composition and the treatment route applied [Ramboll, 2026].

When considering landfill disposal, it is important to recognise that PVDF membranes spend the vast majority of their service life in continuous contact with water. PVDF membranes typically operate for 5–10 years in continuous contact with water. Blue Foot's manufacturing-water and long-term membrane-leachate testing found no evidence of PFAS release under the reported conditions, while independent industry commentary states that significant PFAS shedding during normal PVDF membrane operation has not been demonstrated.

Although no landfill-specific study has been performed on IPC® membranes, this evidence provides no indication that spent membranes would become a significant PFAS-leaching source in landfill conditions..

Blue Foot nevertheless considers controlled end-of-life management to be best practice, with hazardous-waste incineration as the preferred route for spent PVDF membrane products. In an industrial-scale study, PVDF-containing waste underwent complete mineralisation of its organic fluorinated content, with DREs of 99.9999% or higher under the reported operating conditions [Corbin et al, 2026]. The study demonstrates that appropriately operated industrial incineration provides a validated end-of-life pathway for PVDF-containing waste.

These findings add an important element to the lifecycle assessment of PVDF membranes. They demonstrate that a validated industrial end-of-life pathway exists for PVDF-containing waste and reinforce the need to compare membrane technologies across manufacturing, operation, service life, replacement frequency, and end-of-life treatment.

10 Alternative Materials Must Be Evaluated Across Their Entire Lifecycle

Potential alternatives to PVDF exist, including polyethersulfone (PES), polyacrylonitrile (PAN), chlorinated polyethylene (CPE) and ceramic membranes.

However, "alternative exists" is not equivalent to "alternative is technically equivalent."

PVDF became a dominant membrane material because of its:

- Chemical resistance
- Oxidant tolerance
- Mechanical toughness
- Cleaning resilience
- Long service life

Arkema specifically highlights superior resistance to chlorine, sodium hypochlorite, chloramines, chlorine dioxide and other oxidants commonly encountered in water-treatment applications. [Arkema-5], [Arkema-2]

A shift away from PVDF could potentially result in:

- Shorter membrane lifetime
- More frequent replacement
- Reduced tolerance to aggressive cleaning

- Increased material consumption
- Higher lifecycle costs
- Potential release of polymer-specific degradation products or additives

These are lifecycle considerations that should be evaluated on an application-specific basis. [Arkema-5], [Pearce, 2025].

The PES Example

PES is often mentioned as a potential replacement material.

However, replacement should not be evaluated solely on the basis that PES does not contain fluorine.

Published scientific work reports release of Bisphenol-S (BPS) from degraded PES and PPSU materials under environmental weathering conditions involving UV exposure, elevated temperatures and oxidative degradation. The study concerns weathered materials and does not demonstrate release from water-treatment membranes during normal operation. Nevertheless, it highlights the importance of evaluating the full environmental profile of replacement materials. [Yang Li, 2021]

Regardless of future regulatory developments, this illustrates the broader principle of avoiding regrettable substitution:

- Replacing a proven material solely because it contains fluorine, without evaluating durability, service life, resource consumption and potential secondary emissions, may not reduce overall environmental impact.

Regulatory and engineering decisions should therefore consider:

- Manufacturing emissions
- Operational performance
- Service life
- Replacement frequency
- End-of-life management
- Potential release of emerging contaminants

[Yang Li, 2021], [membraneco...ltancy.com]

11 Regulatory Context

The proposed EU PFAS restriction remains under development.

Multiple water-industry sources continue to discuss how future restrictions could affect PVDF membrane manufacturing and use. [thembrsite.com], [aquatechtrade.com]

At the same time, Water Europe has emphasised the importance of balancing PFAS regulation with maintaining essential water and wastewater treatment functions and specifically references PVDF membranes for water treatment when discussing fluoropolymers of low concern. [watereurope.eu]

Blue Foot supports a science-based regulatory approach that considers both environmental protection objectives and the essential role of water-treatment infrastructure.

12 Confidence for Existing and Future Projects

The available evidence indicates that:

- PVDF is fundamentally different from low-molecular-weight PFAS compounds. [Korzeniowski et al, 2022]
- PVDF membranes are recognised by the water sector as important treatment technologies. [watereurope.eu]
- Membrane technologies are part of the treatment solutions used to manage PFAS contamination. [watereurope.eu]
- Major suppliers have transitioned toward fluorosurfactant-free production technologies. [Arkema-2], [solvay.com], [syensqo.com]
- Blue Foot's testing has not identified evidence of PFAS release from IPC® membrane manufacturing wastewater or membrane leachate under the tested conditions.
- Blue Foot's PFAS verification is performed on finished IPC® membranes after completion of a manufacturing process that includes oxidative NaOCl rinsing, providing additional relevance to oxidising conditions encountered during membrane manufacture and cleaning.
- Proposed alternative materials should be evaluated based on their complete lifecycle impacts rather than fluorine content alone. [Yang Li, 2021], [Arkema-5]
- The PVDF polymer grade used by Blue Foot is certified to NSF/ANSI/CAN 61, one of the most widely recognised health-effects standards for materials and components used in drinking water systems.
- Industrial-scale research reports complete mineralisation of organic fluorinated content in tested PVDF-containing waste and DREs of 99.9999% or higher under the reported incineration conditions.

Blue Foot's Position

Blue Foot Membranes believes that decisions regarding membrane materials should be based on scientific evidence, actual environmental performance and contribution to water quality.

- **PVDF membranes are not only subject to the PFAS discussion; they are also part of the water industry's solution to PFAS contamination.**
- **Blue Foot's testing has not identified evidence of PFAS release from IPC® membrane manufacturing wastewater or membrane leachate under the reported test conditions.**
- **For IPC® membrane production, Blue Foot sources PVDF grades that are manufactured without fluorosurfactant-based production agents and verifies the performance of the finished membrane product.**
- **The PVDF polymer grade used in IPC® membranes is certified to NSF/ANSI/CAN 61, a widely recognised health-effects standard for materials and components used in drinking-water systems.**
- **Available evidence supports both responsible operation and validated end-of-life management of PVDF membrane products.**
- **PVDF remains the most widely used, well-established membrane material for drinking water, wastewater treatment and water reuse applications.**

For these reasons, Blue Foot continues to regard PVDF membrane technology as a proven, extensively tested, evidence-based and future-ready solution for water and wastewater treatment. [watereurope.eu], [Shah et al, 2021], [thembrsite.com]