Til: restrictiePFAS (E7), DE (E1 (E1), P1 (E1), Toke Winther ([redacted]@mst.dk), E2 (E2), P2 (E3)
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Fra: P9 , P9 (WTS) (E8)
Titel: Industrial use of fluoropolymers in ultrafiltration membranes
Sendt: 17-06-2022 22:47
Bilag: 2022 06 17 Suez Letter to EEA Members.pdf; Appendix A - Case Studies on PFAS Removal.pdf; Appendix B - Information on WTS PVDF membrane.pdf; Appendix C - Suez UF & MBR Installations.pdf; Appendix D - 2018 01 30 HENRY Polym of low concern.pdf; Appendix E - 2022 06 09 SUPPLIERS Polym of low concern.pdf;

Dear Madam or Sir,
Suez Water Technologies and Solutions (WTS) is a global provider of ultrafiltration membranes used for water and waste water treatment. We manufacture both fluoropolymer (PVDF) and poly ether sulfone (PES) hollow fiber membranes in our factory in Europe. In light of the ongoing review of regulations for PFAS compounds in the EEA, we have decided to reach out directly to provide the attached letter and supplemental documents to highlight the industrial use of these polymers for membrane filters and explain the importance related to the need for clean water and protection of the environment throughout the European community and the world. We hope the information provided will be useful in your assessment and we are available to answer any questions or provide further information if needed.

We remain at your disposal.

P9 **, Ph.D., P. Eng.**
Ti1
SUEZ Water Technologies & Solutions

M + 1 [redacted]
T +1 T1
E8
www.suez.com

3239 Dundas St. W. | Oakville, ON, L6M 4B2, Canada

The acquisition of SUEZ by Veolia has closed, as of January 18, 2022. The Water Technologies & Solutions business is now part of Veolia and operating under the conditions put forth by regional regulatory authorities. During this transition period, our business operations will continue as normal, independent from the rest of Veolia, and also independent from the newly created "New Suez".

Water Technologies & Solutions

3600 Horizon Blvd
Trevose, PA 19053

Tuesday 7 June 2022

Mr. P1 – Netherlands E7
Dr. P2 – Germany E1
Ms. P3 – Sweden P3 . E1
Mr. Toke Winther – Denmark [redacted]@mst.dk
Mr. P4 – Norway E2
Mr. P5 – ECHA E3

Dear Madam or Sir,

Suez Water Technologies and Solutions (WTS) is a provider of ultrafiltration membranes made of fluoropolymer (PVDF), as well as Polyether Sulfone (PES). We supply our technologies to Water and Wastewater plant constructors and operators in Europe and the rest the world, who are like us, committed to healthier potable water, and water resource protection and sustainability through direct reuse for irrigation, industrial usages, and replenishment of our surface and ground waters.

Suez WTS has also developed and introduced a range of removal and remediation technologies and services to address contamination of PFAS for industrial, military, and municipal sites as described in the Appendix A. This offer is unmatched in ability to be tailored to specific situations at the lowest possible capital and operating expenditure.

We made the decision to contact you directly through this letter in order to provide an explanation of the criticality of both PES and PVDF filtration membranes for water and wastewater treatment which are both essential to our society. WTS manufactures membranes at our factory located in Europe (Hungary) and we are able to provide solutions for different applications and achieve the highest finished water purification, including eliminating pathogens (parasites, bacteria and viruses), micropollutants (such as pesticides, pharmaceuticals, personal care products (PCPs), endocrine disruptors (EDCs)) and microplastics. The WTS PES membrane is used for potable or industrial water production where source water contains low levels of solids and dissolved organic matter (e.g., ground water sources or low turbidity surface water). The WTS PVDF membrane is used for treating municipal sewage and industrial wastewaters and, increasingly, surface water bodies subject to runoff due to Climate Change. These impacted surface waters contain high levels of turbidity and pollutants. PVDF membranes have superior properties that allow them to be used in these challenging applications, whereas PES membranes are not suitable. For this reason, the water and wastewater industry relies on PVDF membranes for these critical applications and considers this polymer to be essential to sustaining a substantial install base of existing water and wastewater treatment plants and to meet the growing need for this advanced treatment solution across Europe and the rest of the world.

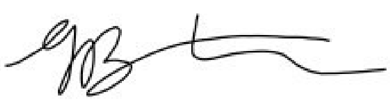
Our PVDF membrane characteristics and applications are described in more details in the Appendix B. Our list of references can be found in the Appendix C, detailed by country and essential uses for water and wastewater treatments.

WTS is aware of the concerns raised over certain PFAS compounds. For this reason, it is important for us to highlight the significant differences in the properties between PVDF which belongs to the "polymeric PFAS" group of compounds and the "non polymeric PFAS" type of compounds (e.g., PFOA and PFOS). PVDF has high molecular weight, is insoluble in water and is not able to penetrate human and animal cells. WTS is not aware of any issues raised in regard to the break-down of our PVDF membranes or PFAS compounds leaching from our PVDF membranes throughout our extensive installations of water and wastewater treatment plants. In summary, we see no risks associated with PVDF and to the contrary we see PVDF as necessary in the industrial use of membranes for water and wastewater treatment which is critical to public health and to protecting the environment.
We attached in Appendix D and E two position papers that illustrate more in details the impact of both categories of PFAS and the distinction that should be made between the "Polymeric" and the "Non Polymeric".

We are at your disposal for any questions that you may have before completing your evaluation on PFAS. You can contact:

- P6 , UF Commercial Leader in Europe, E4
- P7 , UF and RO Global Technology Leader, E5
- P8 , Ti1 , E6

Best regards,



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Global ZeeWeed Business P20

Attached Appendices:

- Appendix A: WTS brochure for PFAS remediation and removal,
- Appendix B: Information on WTS PVDF membrane applications, critical properties and impact of transitioning to a non-fluoropolymer alternative,
- Appendix C: WTS installed base in Europe of PVDF membranes,
- Appendix D: A critical review of the Application of Polymer of Low Concerns (Author: P10 – 30 January 2018),
- Appendix E: A critical review of the Application of Polymer of Low Concerns II (Author S.H Korzeniowski– 5 June 2022).

Water Technologies & Solutions
Technical Paper

PFAS removal in the United States

Two Case Studies Compare Three Removal Technologies

Background

Companies in sectors as diverse as power generation, semiconductors, refining, chemical manufacture, consumer packaging, outdoor equipment, clothing, and flooring materials are grappling with the rapidly growing concern over the use, discharge, and remediation of Poly- and Perfluoroalkyl substances, known as PFAS. With the list of PFAS compounds growing continually, and with the list now numbering more than 4700 different species, the characterization, testing, removal, concentration and destruction challenges are multiplying in complexity. Fortunately, there is an answer to address and manage the complexity. Industry is increasingly turning to SUEZ – Water Technologies & Solutions, for assistance in mitigating the challenges of PFAS in their processes, wastewater, groundwater, and the local environment. SUEZ deploys its expertise in recognition, testing, characterization, pretreatment, concentration, removal, remediation, destruction and regulatory compliance. We are the one stop shop for any industrial, municipal or military organization, that is today grappling with the complex questions surrounding this increasingly recognized threat.

Many companies are getting themselves "ahead of the curve." While the use and discharge into either a receiving body of water, or into the atmosphere, may not currently be regulated by the EPA, or subject to local or state Environmental limits, companies are nevertheless taking stock of their use and potential release mechanisms for various PFAS materials, including air emissions. Whether the original source is from an Industrial Process, Fire Fighting Foam, whether manufactured via Electrofluorination, or Telomerization, whether the material is an original PFAS or a so called NEW PFAS material (or a mixture), SUEZ has the answers for our customers today.

In this paper, we share[1] two recently introduced solutions for customers located in the United States.

Figure 1 **SUEZ responds immediately when you have a need, where you have a need, with the combination of technologies that you need, and at the flow rate required, anywhere in the world.**

Find a contact near you by visiting www.suezwatertechnologies.com and clicking on "Contact Us."

*Trademark of SUEZ; may be registered in one or more countries.

TP1220EN.docx Apr-21

CASE STUDY #1 – PFAS Removal at a US Customer Site

Challenge

This customer faced a challenging mix of PFAS materials in their process water, resulting from both incoming source water and material aids needed in the process. The incoming challenge was thought to be a mix of PFCAs (perfluoro carboxylic acids) and PFSAs (perfluoro sulfonic acids). Upon testing, SUEZ identified PFOA (perfluorooctanoic acid), PFOS (perfluorooctane sulfonic acid), PFHpA (Perfluoroheptanoic acid), PFNA (Pefluorononanoic acid), and new PFAS compounds including PFPA (Perfluoro-2-propoxypropanoic acid), together with other interfering components including alcohols and hydrocarbons. Table 1 shows a partial list of the process parameters and water chemistry are shown below:

Figure 2: SUEZ has extensive analytical laboratory capabilities globally

Table 1: process parameters and water chemistry at customer site

Desired flow rate	350 gpm
Pressure	80 psi
Temperature	70°F
P-Alkalinity	210 ppm as $CaCO_3$
M-Alkalinity	330 ppm as $CaCO_3$
Chlorides	120 ppm
Sulfate	8 ppm
Nitrate as NO_3	11 ppm
pH	9
Suspended solids	<1 ppm
Turbidity	<1 NTUs
TOC (ppm)	<20
Aromatics	Non-detect
PFOA (perfluorooctanoic acid)	0.2 ug/L
PFOS (perfluorooctane sulfonic acid, sulfonate)	1.2 ug/L
PFHpA (Perfluoroheptanoic acid)	0.7 ug/L
PFNA (Pefluorononanoic acid)	0.1 ug/L
NEW PFAS compounds (total)	0.5 ug/L
PFPA (Perfluoro-2-propoxypropanoic acid)	0.3 ug/L
Other PFAS	0.2 ug/L
Grand Total PFAS in water	2.9 ug/L
Desired PFAS – treated product water	0.01ug/L

SUEZ engineers modeled various removal and concentration mechanisms to arrive at the optimal solution. Three well known technologies available for PFAS removal include, but are not limited to, Reverse Osmosis, Carbon Adsorption, and Specialty Anion Exchange Resin. Some of the advantages and disadvantages of these technologies are shown in the summary table below:

The table below offers a view of the advantages and disadvantages of several removal technologies:

	Parameter	Carbon	Resin	Reverse osmosis
PFAS removal	Chain removal effectiveness (C4-C5)	Challenging on carboxylates	Challenging on carboxylates	Removes 95-99%
	Chain removal effectiveness (C6-C9)	Lower capacity/ft³ vs resin	3-5x more capacity/ft³ vs carbon	Removes 95-99%
	Empty bed contact time (EBCT) needed	8-10 minutes	2-3 minutes per vessel	n/a
	Effect of capacity and EBCT on vessel volume	Need 6-8 times more media vs resin	Fewer vessels vs carbon	n/a
	Effect on lifecycle cost	Lifecycle cost can be higher vs resin	Can be less costly vs carbon	Depends on water supply
	Effect on equipment footprint consumed	2-3x more footprint required	One half to one fifth the footprint	Can reduce footprint
Regulatory	Growing concern around short chain PFAS	Not as effective on short chain (especially carboxylates)	Not as effective on short chain (especially carboxylates)	Not widely used yet
	Regulatory approval status - remediation	No impediments to use in remediation	No impediments to use in remediation	No impediments to use in remediation
	Regulatory approval status - drinking water	Approved almost everywhere	Only a handful of states, case by case	Not widely used yet
Media robustness	Robustness of media against TOC and TSS	Very robust, good pretreatment to resin	TOC and TSS must be <1ppm	Robust
	Forgiveness against water contamination	Not particularly sensitive	Sensitive, need computer model	Robust
	Capable of removing "other" TOC species	Very capable	Less capable vs carbon	Robust
	Sensitivity to high TDS	Not sensitive	Sensitive, need computer model	Robust
Recovery rate	Water recovery %	99-100% of water recovered	99-100% of water recovered	85-90% of feed becomes permeate
Waste stream	Generation of wastewater stream	No	No	Concentrate stream must be treated
Media cost	Ability to reuse or regenerate media	Re-fired, loss of 15% of capacity	Typically use once and incinerate	Membranes last 3-5 years

Solution

SUEZ evaluated alternative technologies to meet this customer's challenges

Reverse osmosis (RO) – As one may surmise from the table, RO (figure 3) often has exceptional ability to remove PFAS materials. The molecular weights are typically above 200 Daltons, and furthermore, most PFAS materials are charged in normal aqueous solutions, having ionized one hydrogen (proton) from the carboxylic or sulfonic functional group. This ionization can be expected to be complete across the full range of normal pH encountered in ground, process, and waste water. In any case, since the pH in this situation is high (pH = 9) there is no concern that the PFAS materials were not fully ionized. Because of the molecular weight, the hydrophobicity of the molecule, and the charge, SUEZ determined RO would be able to remove the PFAS materials to greater than 99.9% – at least 3 logs of removal with a single pass membrane system.

In addition to this removal, the RO also removes a range of other contaminants, such as TOC, suspended solids, and ionic contamination, which would be helpful to the customer's process. While this would have been sufficient for the process involved at this customer, a second challenge presented itself. The RO—any RO—produces a waste stream that contains all the contaminants that do not pass through the membrane. Thus, all the PFAS materials would be concentrated into a stream of approximately 35 gpm, and this stream would have to be further treated to permanently remove the PFAS before discharge. While SUEZ makes RO systems that can achieve 90%+ recovery, the existence of this waste stream was deemed to be too complicated for the application. The customer wanted something simpler.

Figure 3: SUEZ proprietary membrane purification element and Membrane System. Capable of 3+ log removal of PFAS.

Carbon Adsorption – The second solution considered was carbon adsorption (Figure 4). Carbon has been used from time immemorial, for purifying drinking water, process water, air, and a host of other process streams. Due to its vast surface area, and because of the attraction of van der Waals forces at the atomic level within granular carbon, the material is capable of removing a vast variety of contaminants from water, air and other streams. The advantage of carbon in this case, is that it can remove a lot of different contaminants, and is somewhat forgiving of particles and turbidity in the water. Carbon also attracts traditional organic molecules (molecules that contain lots of C-C bonds saturated with Hydrogen) very strongly, and with high capacity. In many cases, there are few alternatives for the use of carbon adsorption, as it may be difficult or impossible to find a suitable substitute. Unfortunately, PFAS is not a traditional organic molecule. It is purely man-made, never occurring in nature. The very name PFAS signifies the near or complete saturation of the Carbon bonds with Fluorine atoms, rather than with Hydrogen atoms, and this aspect renders the PFAS molecule much less readily attracted to carbon. Therefore, while carbon can adsorb some PFAS, both the kinetics and capacity of carbon suffer when compared to other removal materials. Nevertheless, since the customer's water contained other organics, and since organics normally would need to be removed in conjunction with PFAS removal, carbon was carefully considered, either for use by itself, or in conjunction with (upstream of) Specialty Ion Exchange resin. Two factors tilted the decision away from carbon in this case. First, a high removal efficiency for the benign 'other' organics was found to be not necessary. Second, and more importantly, the use of carbon would have necessitated over 5 times the number of vessels, quantity of media, plus associated piping, space, pumping and monitoring, to achieve the same result.

Figure 4: Tanks at the Manufacturing Plant.

Figure 5: Specialty Ion Exchange Resin

Specialty Anion Exchange Resin – The third technology evaluated for the application was Specialty Anion Exchange Resin (Figure 5). Anion Exchange Resin has advantages and disadvantages, depending on the water matrix, the type of PFAS encountered, and the floor space available for equipment. Two exceptional advantages of resin are:

- The kinetics of resin removal are 5-8 times higher than those of Carbon. So the speed of removal is in the same order of magnitude as Reverse Osmosis. Not instantaneous, but fast. In general, an EBCT[2] or Empty Bed Contact Time of approximately 1.5 to 3.0 minutes total, is needed for the removal of various PFAS materials to a level of non-detect (Non-detect is variously reported as around 1 – 5 ppt, or 0.001 – 0.005 ug/L). For comparison, Carbon might need an EBCT of

8-10 minutes (or more), also depending on the water matrix, and the type of PFAS encountered. For both carbon and resin, Carboxylic acids are not removed as well as sulfonic acids, and short chain PFAS such as butanoic (C4) are not removed as effectively as long chains such as nonanoic (C9). Since carbon does not rely upon ionic charge as a removal mechanism, it's kinetics are not as favorable as those for resin.

- The dual removal mechanism of resin (both ionic charge, and affinity/van der Waals) tends to give resin approximately 5-20 times as much mass loading capacity per cubic foot of media. The capacity sometimes allows resin to last longer before breakthrough of the offending PFAS compound. Typically, PFOA or another carboxylic will break through first, and especially so for shorter chain lengths.

After evaluating all the choices at this customer, SUEZ engineers determined that the most cost-effective solution would be a two-pass container system with resin loaded into a lead lag configuration. Lead lag typically adds 30% to 50% to the capacity of a resin system compared to single pass, and thus is generally preferred for long term commitments (Figure 6).

Figure 6: SUEZ proprietary multi vessel water purification system with interstage testing and automation control

Results

1. Specialty Anion Exchange Resin, for broad range PFAS removal, was selected as the final choice.
2. The selected treatment train was a simple pump➔vessel➔ arrangement, with the two vessels able to exchange place readily in the lead – lag operation paradigm.
3. The resin was briefly backwashed to stratify the resin. This is not required but is recommended to maximize capacity.
4. The resin was then forward rinsed with approximately 100 to 500 bed volumes to equilibrate to the alkalinity, and anionic content of the feed.
5. PFAS-out Specification was met immediately.
6. PFAS testing was completed at least weekly for the first few months, then switched to monthly thereafter.
7. An uptick in testing frequency is planned toward the end of the expected run length minus 3 months.
8. When the lead vessel "breaks through", typically to a level of 30-40 ppt of PFAS, the lead vessel is emptied, refilled with new resin, and converted into the new lag vessel (with valves, not by vessel relocation).
9. The extracted used resin is put into super sacks, allowed to drain for 7 days to 'drip dry' over an approved drain, then picked up by the vendor and incinerated at high temperature (accompanied by certificate).
10. The used resin is typically not considered hazardous unless chemically altered. The PFAS is bound strongly to the resin.
11. Meantime the former lag vessel, at that time typically has plenty of capacity left.
12. Thus, the former lag vessel is switched to the new lead position.
13. Each vessel holds 95 cubic feet of Specialty Anion Exchange Resin supplied by the industry leader in specialty resins.
14. The expected throughput for the water encountered, was estimated to be 150,000 Bed Volumes, which would equate to approximately 200-300 days of run time before vessel exchange, based on the customer's 70% - 80% expected up (running) time.
15. After several months of successful running time, the system continues to perform to expectation and is consistently reducing the PFAS-out to a level of <0.01 ug/L.
16. The customer is extremely happy with the result.

CASE TWO—PFAS Removal at a Different Customer in the United States

Challenge

As before, this customer faced a mix of PFAS materials, together with many other components in the process water. In this case there were four significant PFAS compounds, some found to be already in the incoming feed water for the process (intake contamination), and some being added by the customer as a process aid. Part of the incoming challenge was thought to be a mix of PFCAs (perfluoro carboxylic acids) and PFSAs (perfluoro sulfonic acids). However, customer and SUEZ testing identified PFOS (perfluorooctane sulfonic acid), PFBA (Perfluorobutane sulfonic acid), PFHxA (Perfluorohexanoic acid), and PMPA (known variously as Perfluoro methoxy propanoic acid or Perfluoro-2-methoxypropanoic acid) together with several potentially interfering fluorinated compounds, some of which are not PFAS.

The main challenge for the customer was to reduce the volume of water that needs to be treated for safe disposal. This customer had been removing the waste from site, for treatment by incineration or other techniques. By substantially reducing the volume of treated water the customer was enabled to save over $1,000,000 per year in operating costs. Furthermore, the in-process water was able to be converted to PFAS free boiler feed water, thus reducing the water footprint of the facility by over 80%. This became a double win for the customer. Table 2 shows a partial list of the process parameters and water chemistry.

Table 2: process parameters and water chemistry at customer site

Desired flow rate	110 gpm
Pressure	30 psi feed
Temperature	65°F
Desired Recovery of Overall System	80%
P-Alkalinity	4500 ppm as $CaCO_3$
M-Alkalinity	6300 ppm as $CaCO_3$
Sulfate	6630 ppm
Sodium	6520 ppm
TDS	17,335 ppm
pH	9.6
Suspended solids	10 ppm
Turbidity	5 NTUs
TOC	550 ppm
Various Alcohols (<C7)	150 ppm
Aromatics	Non-detect
PFOS (Perfluorooctane sulfonic acid)	1.15 ug/L
PFBA (Perfluorobutanoic acid)	0.12 ug/L
PFHxA (Perfluorohexanoic acid)	0.50 ug/L
PMPA (Perfluoro methoxy propanoic acid)	0.94 ug/L
Grand Total PFAS in water	2.80 ug/L
Desired PFAS – treated product water	Non-detect

Solution

As in Case One, SUEZ engineers evaluated the potential contribution of all three key technologies in the effort to treat the in-process water. It quickly became apparent that multiple technologies would likely be needed to meet the objective of non-detect for boiler water, together with 80% recovery of the process water. The solution was pilot tested for a period of months and proved to be feasible and cost effective.

The best solution was a combination of all three SUEZ technologies: Membrane + Carbon + Ion Exchange, as shown in the "results" item 2, below.

The challenge could be summarized by:

1. Suspended Solids removal
2. Concentration of PFAS into 20% of original water volume
3. Removal of residual organics from Membrane permeate
4. Polishing of the 80% purified water to prepare it for boiler feed.

After the successful pilot test the customer asked SUEZ to install a full-scale Mobile system to begin treatment immediately. The results have been excellent, and the customer is pleased.

Results

1. A combined technology approach, for broad range PFAS removal, was selected as the final choice.
2. The selected treatment train is SUEZ Filtration➔SUEZ Membrane pass 1➔SUEZ Membrane pass 2➔Carbon Adsorption➔Ion Exchange Polish
3. The first SUEZ Membrane is for high TDS applications. The second is for polishing the permeate further. Each of the 2 membrane passes, reduces PFAS concentration in the permeate by at least 3 logs of reduction, so that the product is below the detection limit.
4. The standard ion exchange resin was then able to produce 0.06 micro-Siemen water for boiler feed.
5. PFAS-out and boiler feed Specifications were met within the first week as the system stabilized.
6. Periodic PFAS testing and other parameter testing was planned and implemented.
7. Membranes will be tested at the end of the engagement to ensure there is no "cycling up" or concentration of PFAS in the membrane. None is expected.
8. The ion exchange resin is not being relied upon to remove any PFAS since the two Membrane passes have already achieved that objective. Thus, the resin is standard, rather than specialty resin.
9. The 80% recovery objective was met, saving water, and the concentration of waste to a 20% volume was also met.
10. The customer is very happy with the result.

Overall Summary

SUEZ leads in the technology of PFAS contamination removal and remediation, drinking water treatment, waste water treatment, plant operation and maintenance, sludge waste management, and many other aspects of water resource management. In these two case studies we reviewed the solutions for two challenging in-process PFAS control, concentration, and removal issues. In the first case, after a thorough technical comparison, it turned out that a simple 2 vessel, specialty resin-based solution in the lead lag configuration proved to be the most effective and economic solution. It was implemented within a matter of weeks, and the client is delighted with the result.

In the second Case Study, a more complex challenge presented itself. SUEZ designed and installed a system to a) treat 110 gpm of waste water, b) remove PFAS from the waste water, c) concentrate the PFAS waste water to 20% of the original volume, d) achieve non-detect PFAS in the Membrane permeate, e) polish the permeate with Ion exchange, and f) recycle the 80% to the boiler. This solution saved the customer more than $1,000,000/year after treatment costs were factored in.

Figure 7: SUEZ offers systems from 5 gpm up to 5000 gpm and beyond. Fully Mobile, ready for immediate emergency deployment.

SUEZ Difference

- When you engage with SUEZ, we will start with testing your water streams, perform a mass balance, evaluate your discharge conditions, understand and master your regulatory framework, measure your economics, consider local and national "headline risks", and provide you the best, tailored, overall solution.
- We may use technologies including Ion Exchange, Carbon Adsorption, Reverse Osmosis, along with pretreatment including Clarification, Ultrafiltration, Media Filtration; as well as concentration technologies such as thermal/crystallization/zero liquid discharge, along with Laboratory and on-site Water Analysis, among many other services.
- Understanding of the special needs of Industrial, Municipal, Military and Firefighting use cases, for remediation, process treatment, drinking water, discharge, regulatory knowledge, solids management, and PFAS destruction.
- As an owner or operator of dozens of municipal and private drinking water systems, municipal drinking and wastewater systems, and solid waste handling or treatment facilities, SUEZ knows your challenge from the perspective of the owner/operator—in other words, from your perspective. Our own operations specialists are available to help with your needs.
- SUEZ serves over 450,000 industrial and business customers globally, generates over $17Bn in annual sales, invests over $120M per year in research and development in 17 R&D centers, located throughout the world, and has been granted over 3,200 patents. We serve the entire range of Industrial, Municipal and firefighting site applications, with over 90,000 employees worldwide.
- SUEZ is the world leader in Total Organic Carbon Analysis with our TOC Analytical instruments, in Remote Monitoring and Diagnostics with our InSight Cloud Based Reporting, and in Analytical Testing with our many laboratories located around the world.
- With over 80 years in the water business, SUEZ is your best available partner to address your PFAS treatment needs.

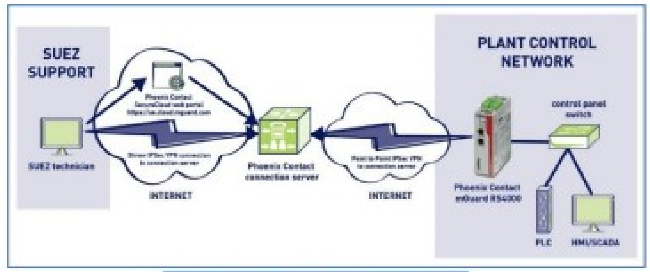


Figure 8: InSight* Remote Monitoring and Diagnostics with Cloud Based Analytics Package. Results available 24/7/365.

[1] *NOTE: Details and figures in the case studies included have been altered or blended between various SUEZ locations, to maintain confidentiality, while preserving valid conclusions regarding technical solutions.*

[2] *EBCT means the amount of time the flowing water remains in contact with the bed of resin or carbon through which it is flowing. It does not refer to the interstitial space, which is why it is called EMPTY bed contact time. For example, a flow of 100 gallons per minute through a bed of 300 gallons (40 cubic feet) of media (carbon or resin) would take 3 minutes. This would equate to an EBCT of 3 minutes.*

Appendix B - Information on WTS PVDF membrane applications, critical properties and impact of transitioning to a non-fluoropolymer alternative

1. Applications where WTS PVDF membranes are used

Case #	Application	Industries involved
Case 1	Filtering water for Drinking water quality with Ultrafiltration membranes (outside-in hollow fiber type)	Municipal drinking water plants
Case 2	Filtering water of industrial quality with Ultrafiltration membranes (outside-in hollow fiber type)	Industrial water treatment plants
Case 3	Filtering biologically treated wastewater with Ultrafiltration membranes (outside-in hollow fiber type) for discharge in surface water bodies, for replenishing depleted groundwaters, or for agricultural or industrial use.	Industrial and municipal wastewater treatment plants

2. Technical properties of PVDF critical to the applications

Case 1

Category	Technical property	Relevant to application	Specification & Measurement standard
Durability	Mechanical strength	Y	Tensile strength >45 MPa (ASTM D638
	Wear resistance	Y	>10 years accelerated test (Suez standard test)
	Mechanical properties (e.g., flexibility)	Y	Elongation at yield > 25% (ASTM D638); Tensile modulus <2200 MPa (ASTM D638)
	Low coefficient of friction		
Inertness – stability	Resistance to harsh chemicals	Y	1,000,000 ppm·hrs NaOCl exposure for membrane cleaning (NaOCl is a critical

			chemical used for removing organic constituents and disinfection
	Resistance to high temperatures		
	Resistance to low temperatures (e.g., cryogenic properties < 50°C)		
	Wide temperature range of operation		
	Weather resistance		
	Biocompatibility		
	High limiting oxygen index		
Functionality	Electrical insulator (high data transmission range)		
	Ionic conductivity		
	Piezoelectric properties		
	Dielectric strength		
	Barrier properties		
	Non-stick properties	Y	Resistance to fouling by organic constituents present in surface waters
	Optical clarity		
	Fire retardancy / smoke suppression		
	Low bacterial / algae growth		
	Low refractive index for optical effects		
	Other (please specify):		

Case 2

Category	**Technical property**	**Relevant to application**	**Specification & Measurement standard**
Durability	Mechanical strength	Y	Tensile strength >45 MPa (ASTM D638

	Wear resistance	Y	>10 years accelerated test (Suez standard test)
	Mechanical properties (e.g., flexibility)	Y	Elongation at yield > 25% (ASTM D638); Tensile modulus <2200 MPa (ASTM
	Low coefficient of friction		
Inertness – stability	Resistance to harsh chemicals	Y	1,000,000 ppm·hrs NaOCl exposure for membrane cleaning (NaOCl is a critical chemical used for removing organic constituents and disinfection
	Resistance to high temperatures		
	Resistance to low temperatures (e.g., cryogenic properties < 50°C)		
	Wide temperature range of operation		
	Weather resistance		
	Biocompatibility		
	High limiting oxygen index		
Functionality	Electrical insulator (high data transmission range)		
	Ionic conductivity		
	Piezoelectric properties		
	Dielectric strength		
	Barrier properties		
	Non-stick properties	Y	Resistance to fouling by organic constituents present in surface waters and in wastewater
	Optical clarity		
	Fire retardancy / smoke suppression		

	Low bacterial / algae growth		
	Low refractive index for optical effects		
	Other (please specify):		

Case 3

Category	Technical property	Relevant to application	Specification & Measurement standard
Durability	Mechanical strength	Y	Tensile strength >45 MPa (ASTM D638
	Wear resistance	Y	>10 years accelerated test (Suez standard test)
	Mechanical properties (e.g., flexibility)	Y	Elongation at yield > 25% (ASTM D638); Tensile modulus <2200 MPa (ASTM
	Low coefficient of friction		
Inertness – stability	Resistance to harsh chemicals	Y	1,000,000 ppm·hrs NaOCl exposure for membrane cleaning (NaOCl is a critical chemical used for removing organic constituents and disinfection
	Resistance to high temperatures		
	Resistance to low temperatures (e.g., cryogenic properties < 50°C)		
	Wide temperature range of operation		
	Weather resistance		
	Biocompatibility		
	High limiting oxygen index		
Functionality	Electrical insulator (high data transmission range)		
	Ionic conductivity		
	Piezoelectric properties		

	Dielectric strength		
	Barrier properties		
	Non-stick properties	Y	Resistance to fouling by organic constituents present in wastewater
	Optical clarity		
	Fire retardancy / smoke suppression		
	Low bacterial / algae growth		
	Low refractive index for optical effects		
	Other (please specify):		

3. **List of potential non-fluoropolymer alternatives (second best alternatives) for each application**

Case #	**Potential alternatives to fluoropolymers that could be considered as alternatives**
Case 1	Polyether sulfone (PES)
Case 2	Polyether sulfone (PES)
Case 3	None

4. **Possible trade-offs that could be expected when alternatives to fluoropolymers are used in these applications**

Case 1		
Criteria	**With Fluoropolymer**	**With non-fluorinated alternatives**
Amount of product used:	75-100 tonnes/year	75-100 tonnes/year
Property comparison:	Tensile strength >45 MPa Elongation at yield 25% Tensile modulus 2200 MPa NaOCl resistance >1,000,000 ppm·hrs	Tensile strength >45 MPa Elongation at yield 6.5% Tensile modulus 2700 MPa NaOCl resistance <250,000 ppm·hrs
Combination of functionalities		PES based outside-in hollow fiber membrane is less flexible resulting in lower

		efficiency (less flow per sqm of membrane area) and is therefore less competitive compared with PVDF based membranes. Furthermore, due to the lower chemical resistance, the PES membrane will undergo embrittlement during the product life, resulting in broken fibers and reduced life expectancy.
Overall performance		Reduced product performance (flow per sqm of membrane) and reduced life expectancy will make the Suez outside-in hollow fiber membrane non-competitive in the global market. Non-EU suppliers of outside-in hollow fiber membranes will continue to use PVDF. 100% of Suez membranes are produced in EU.
Safety & Reliability	Suez uses PVDF free from PFAS processing aids. No low molecular weight PFAS compounds have been measured in the manufacturing of the membranes.	
Application life	15-20 years	5-7 years (represents more cost and more raw materials due to more frequent replacement)
Circularity	Suez is working with our PVDF supplier to develop a recovery and recycling program for membranes.	

Decarbonisation	Reduce carbon footprint through recycling of PVDF.	
(Eco)toxicity comparison	Fluoropolymers including PVDF have thermal, chemical, photochemical, hydrolytic, oxidative and biological stability. They have negligible residual monomer and oligomer content and low to no leachables. Fluoropolymers are practically insoluble in water and not subject to long-range transport. With a molecular weight well over 100,000 Da, fluoropolymers cannot cross the cell membrane. Fluoropolymers are not bioavailable or bioaccumulative. (Henry, Barbara J., Joseph P. Carlin, Jon A. Hammerschmidt, Robert Buck, L. William Buxton, Heidelore Fiedler, Jennifer Seed, and Oscar Hernandez. 2018. A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers. Vol. 14.) Suez is currently carrying out a study on aged membranes (collected from customer sites) to provide further evidence that no PFAS compounds will leach from the membranes over the long-term.	
Other (please describe):		

Case 2		
Criteria	**With Fluoropolymer**	**With non-fluorinated alternatives**

Amount of product used:	75- 100 tonnes/year	75- 100 tonnes/year
Property comparison:	Tensile strength >45 MPa Elongation at yield 25% Tensile modulus 2200 MPa NaOCl resistance >1,000,000 ppm·hrs	Tensile strength >45 MPa Elongation at yield 6.5% Tensile modulus 2700 MPa NaOCl resistance <250,000 ppm·hrs
Combination of functionalities		PES based outside-in hollow fiber membrane is less flexible resulting in lower efficiency (less flow per sqm of membrane area) and is therefore less competitive compared with PVDF based membranes. Furthermore, due to the lower chemical resistance, the PES membrane will undergo embrittlement during the product life, resulting in broken fibers and reduced life expectancy.
Overall performance		Reduced product performance (flow per sqm of membrane) and reduced life expectancy will make the Suez outside-in hollow fiber membrane non-competitive in the global market. Non-EU suppliers of outside-in hollow fiber membranes will continue to use PVDF. 100% of Suez membranes are produced in EU.
Safety & Reliability	Suez uses PVDF free from PFAS processing aids. No low molecular weight PFAS compounds have been measured in the manufacturing of the membranes.	

Application life	15-20 years	5 – 7 years (represents more cost and more raw materials due to more frequent replacement)
Circularity	Suez is working with our PVDF supplier to develop a recovery and recycling program for membranes.	
Decarbonisation	Reduce carbon footprint through recycling of PVDF.	
(Eco)toxicity comparison	Fluoropolymers including PVDF have thermal, chemical, photochemical, hydrolytic, oxidative and biological stability. They have negligible residual monomer and oligomer content and low to no leachables. Fluoropolymers are practically insoluble in water and not subject to long-range transport. With a molecular weight well over 100,000 Da, fluoropolymers cannot cross the cell membrane. Fluoropolymers are not bioavailable or bioaccumulative. (Henry, Barbara J., Joseph P. Carlin, Jon A. Hammerschmidt, Robert Buck, L. William Buxton, Heidelore Fiedler, Jennifer Seed, and Oscar Hernandez. 2018. A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers. Vol. 14.) Suez is currently carrying out a study on aged membranes (collected from customer sites) to provide further evidence that no PFAS compounds will leach	

	from the membranes over the long-term.	
Other (please describe):		

Case 3		
Criteria	**With Fluoropolymer**	**With non-fluorinated alternatives**
Amount of product used:	150– 200 tonnes/year	No known alternative
Property comparison:	Same comments as case 1 and 2	No known alternative
Combination of functionalities	Same comments as case 1 and 2	No known alternative
Overall performance	Same comments as case 1 and 2	No known alternative
Safety & Reliability	Same comments as case 1 and 2	No known alternative
Application life	Same comments as case 1 and 2	No known alternative
Circularity	Same comments as case 1 and 2	No known alternative
Decarbonisation	Same comments as case 1 and 2	No known alternative
(Eco)toxicity comparison	Same comments as case 1 and 2	No known alternative
Other (please describe):	Same comments as case 1 and 2	No known alternative

5. **In case that fluoropolymers were not available for use in the EEA what would happen in these applications?**

Case 1	If the use of PVDF is prohibited, we will have to stop the entire business for wastewater treatment because there is no alternative polymer for the application (Case 3). Without the wastewater market (largest and strongest market), our manufacturing plant located within the boundaries of the EEA will no longer be viable. If the use of PVDF is prohibited for drinking water only, Suez would have to evaluate whether there is a

	business case for a PES based outside-in hollow fiber membrane for use in municipal drinking water and industrial water applications since the properties of this membrane would be inferior to PVDF based membranes. Suez would not be competitive in global markets where non-EU membrane manufacturers could continue to supply PVDF membranes. 100% of Suez membranes are produced in the EU.
Case 2	See above.
Case 3	See above.

6. Expected socio-economic impact if fluoropolymers were no longer available for these applications

Case 1	
Economic impacts:	The PES membrane alternatives for Case 1 require engineering studies and equipment changes to make PES membranes work. Because the solutions using PES membranes will be more complex with additional treatment steps, the cost is expected to be 100's millions euro for making the necessary retrofits. Additionally future membrane treatment plants will also be much more expensive to construct if PVDF membranes are no longer available.
Societal impacts:	As a general statement. Suez's perspective is that PVDF Membrane filtration should fall under Industrial use in the category of **ENVIRONMENT and Health** rather than a Textile category. PVDF filtration membranes are used in the treatment of water and wastewater and are critical to public health and protecting the environment. PVDF filtration membranes are used to filter out contaminants such as pathogens (parasites, bacteria and viruses), micropollutants (such as pesticides, pharmaceuticals, personal care products (PCPs), endocrine disruptors (EDCs)) and microplastics for drinking water production. Without this technology, more complex and expensive solutions will have to be employed to provide removal of these contaminants. For many of the more challenging surface water sources impacted by increasing weather events brought on by climate change, good alternative solutions do not exist.

Case 2	
Economic impacts:	Same as Case 1
Societal impacts:	Same as Case 1

Case 3	

Economic impacts:	An alternative for case 3 does not exist. This means that customers in Europe and globally who have used the technology for up to 2 decades would not be able to obtain replacement membranes for existing municipal and industrial wastewater treatment plants. They would need to go back to conventional concrete clarifiers that would not fit the requirements in term of footprint and not provide the barrier to pathogens and other contaminants previously mentioned. This would result in disruptions and 100's millions euro to retrofit to alternative treatment solutions. In some cases this would mean constructing completely new plants in alternative locations due to existing footprint constraints. Additionally, future wastewater treatment needs would have to be met with more expensive solutions. Since the annual MBR market is estimated at around five Billion €, solutions costing 50-100% more would result in 2.5-5 Billion €/year additional investment to meet future wastewater treatment needs. For Suez only (not considering the other producers of membranes or sub-suppliers), 1000 jobs would be lost in Hungary, including high level manufacturing, engineering and R&D jobs. Another 500-800 jobs could be lost in other functions within the EEA countries (sales, project engineering, field service, planning, logistics, etc.). The revenue loss for Suez from membrane sales alone would be 250 - 350 Million €/y.

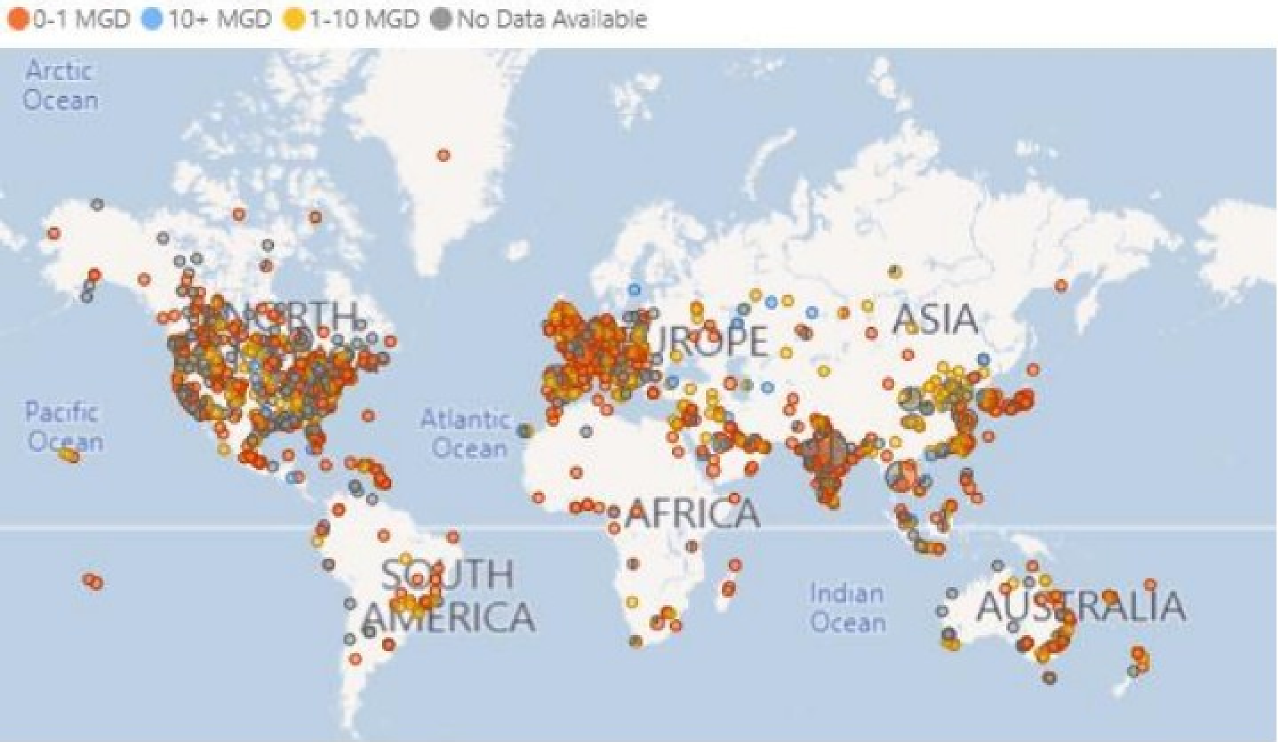
7. Additional information

1. It is critical to distinguish the two types of hollow fiber ultrafiltration membranes: inside-out type and outside-in type. For inside-out hollow fiber membranes, the feed water is fed to the inside bore of the hollow fiber and the clean water passes through the polymer matrix (the separation barrier) to the outside of the hollow fiber. This type of membrane is used on easier to treat applications (e.g., post treatment of potable water, low turbidity surface water). For inside-out hollow fiber membranes, poly ether sulfone can be used effectively. For outside-in hollow fiber membranes, dirty water is on the outside of the hollow fiber and the clean water is collected from the inside of the hollow fiber. Outside-in hollow fiber membranes are used on higher solids and more fouling feed waters (e.g., industrial applications, wastewater treatment, high turbidity surface water). Due to the challenging applications, outside-in hollow fiber membranes are subjected to more aggressive cleaning, including agitation with air scouring and use of high concentrations of cleaning chemicals (e.g., sodium hypochlorite and acids). For these reasons, outside-in hollow fiber membranes are almost exclusively made from PVDF (~100% the case for outside-in membranes used to treat wastewater). Suez makes both inside-out (PES based) and outside-in (PVDF) hollow fiber membranes. However, 90% of the membrane applications require the robust outside-in (PVDF) type hollow fiber. (External references: https://www.thembrsite.com/blog/choosing-mbr-membrane-materials/)
2. Suez uses only PVDF produced without fluorinated processing aids. Suez has confirmed the absence of low molecular weight PFAS compounds in the manufacturing of our membranes.
3. Due to the economic value of PVDF and interest in sustainability, Suez has been actively involved with our supplier of PVDF looking at the potential for recycling end of life membranes. Although this is an early stage initiative, we see a strong potential for recovery and recycling of used PVDF to be used in membranes and other applications employing PVDF. Since industrial and municipal end-users typically have 100's – 1000's of membrane modules and maintain on-going connection to the Suez After-market organization, we would anticipate a high recovery potential compared with other industries (e.g., consumer type products).
4. Suez PVDF membranes have been rigorously tested and meet drinking water standards throughout the world. Certifications include: NSF 61, NSF 419, KTW (Germany), KIWA (Netherlands), ACS (France), DWI (UK), ICIM (Italy), Hungary, Poland, Czech, MOH (China), KWWA (Korea).

Additional references: https://www.fpp4eu.eu/case-studies/multifunctional-membrane/; https://www.arkema.com/global/fr/resources/post/kynar-pvdf-membrane-ultrafiltration-of-toulouse-wastewater/; https://hpp.arkema.com/en/markets-and-applications/water-and-environment/water-filtration-membranes/

Suez UF & MBR Installations

As of 2022

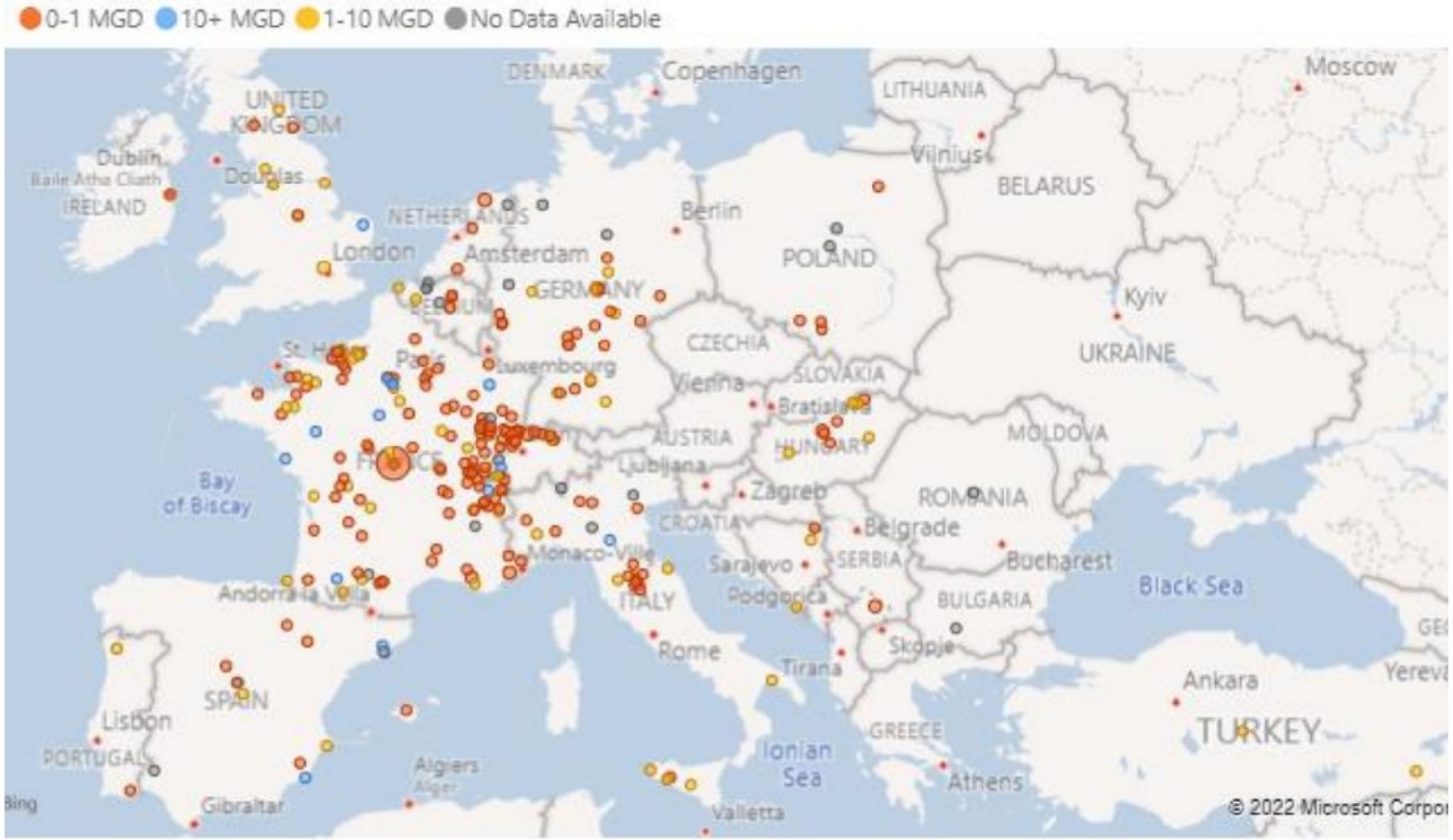


- Above is all installs in the globe
- 3233 total installs
- 1515 Case 1 and 2 (Muni/ind Water)
- 1718 Case 3 (MBR)

TYPE OF SYSTEM	(All)	Global ZeeWeed Installs
Row Labels	Sum of SUMCapacity (Converted, MLD)	Sum of Count of INSTALL BASE
ANZ	848	103
East Asia	934	120
Europe	8480	822
GRC/Korea/Japan	4847	415
LAM	620	77
MEA	1553	186
NAM	9547	1081
South Asia	617	429
Grand Total	**27446**	**3233**

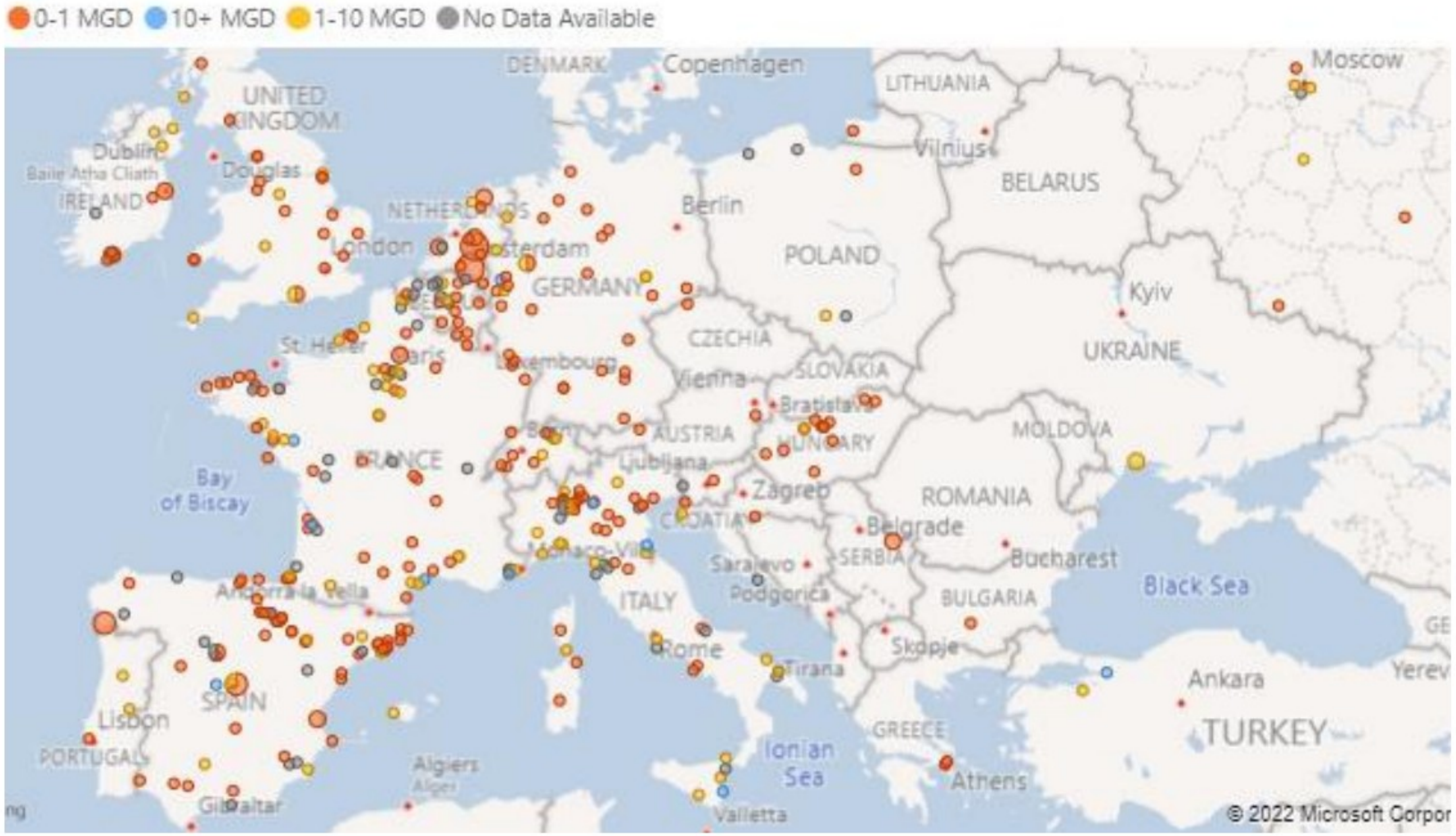
TYPE OF SYSTEM	Case 1 and 2 (Muni/Ind Water)	Global ZeeWeed Installs
Row Labels	Sum of SUMCapacity (Converted, MLD)	Sum of Count of INSTALL BASE
ANZ	637	53
East Asia	662	89
Europe	5138	391
GRC/Korea/Japan	2411	178
LAM	438	32
MEA	1128	101
NAM	6954	579
South Asia	121	92
Grand Total	**17490**	**1515**

TYPE OF SYSTEM	Case 3 (MBR)	Global ZeeWeed Installs
Row Labels	Sum of SUMCapacity (Converted, MLD)	Sum of Count of INSTALL BASE
ANZ	211	50
East Asia	272	31
Europe	3341	431
GRC/Korea/Japan	2437	237
LAM	182	45
MEA	425	85
NAM	2593	502
South Asia	496	337
Grand Total	**9956**	**1718**



Case 1 and 2 (Muni/Ind Water)

Case 1 &2 (Muni/Ind Water)	Average Day Flow	Total IB
Row Labels	**Sum of Capacity (Converted, MLD)**	**Sum of Count**
Belgium	39.7	8
Bulgaria	0.0	1
France	1074.4	157
Germany	63.4	29
Greenland	2.4	1
Hungary	67.5	13
Ireland	0.7	1
Israel	5.8	1
Italy	2804.0	25
Kazakhstan	38.0	5
Netherlands	3.2	6
Poland	5.4	6
Portugal	25.3	1
Russia	131.8	6
Spain	401.1	17
Switzerland	94.1	15
Turkey	33.4	2
United Kingdom	157.2	11
Israel	0.6	1
Grand Total	**4948**	**306**



Case 3 (MBR)

Case 3 (MBR)	Average Day Flow	Total IB
Row Labels	**Sum of Capacity (Converted, MLD)**	**Sum of Count**
Austria	2.5	2
Belgium	68.1	20
Bulgaria	0.4	1
Cyprus	49.5	3
Czech Republic	1.0	1
Denmark	0.0	1
France	650.1	88
Germany	95.2	30
Greece	1.8	3
Hungary	23.0	14
Ireland	21.7	8
Israel	55.9	9
Italy	494.6	61
Netherlands	37.2	16
Poland	13.5	6
Portugal	31.4	2
Russia	386.3	14
Serbia	1.7	2
Slovenia	3.9	3
Spain	282.3	84
Sweden	535.0	1
Switzerland	71.6	12
Turkey	169.0	2
United Kingdom	72.8	22
Israel	16.2	5
Grand Total	**3085**	**410**

Miljøministeriet
Miljøstyrelsen

Den 12. juli 2024

Aktdetaljer

Akttitel: PFA Restriction Proposal
Aktnummer: 18
Sagsnummer: 2020 - 15422

Akt-ID:	3826794
Dato:	06-10-2021 11:16:12
Type:	Indgående
Dokumenter:	• [1] PFA Restriction Proposal.eml (MEDTAGES IKKE) • [2] 20211006_mcp engineering plastics.pdf

mcp engineering plastics

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Date: 15th September 2021

Kind attention:

Mr. [redacted] P1 - Netherlands restrictiePFAS@rivm.nl
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Mrs. [redacted] P3 - Sweden [redacted] E1
Mr. Toke Winther - Denmark towin@mst.dk
Mr. [redacted] P4 - Norway [redacted] E2
Mr. [redacted] P5 - ECHA [redacted] E3

Through: fluorseals S.p.A - Via Tribolina, 20/22 - 24064 Grumello del Monte (BG) - Italy

The members of fluorseals S.p.A mainly focus on processing of Fluoropolymers, part manufacturing and its applications, the involvement of downstream users in PFAS process.

Subject: PFAS restriction proposal & request for exemption of FLUOROPOLYMERS

Reference: PFAS - Registry of restriction intentions until outcome (RoI) dated 15th July 2021

Dear Sir/Madam,

With regards to Registry of Intention (RoI) filed by 4 EU Member States (Germany, the Netherlands, Sweden, and Denmark) & Norway for the restriction of PFAS, we, a member of fluoropolymer downstream user industry, hereby, would like to share some salient facts related to the importance of fluoropolymers, critical functionalities, performance and benefits of its applications to society, while acknowledging concerns regarding PFAS emissions related to the use of fluoropolymers and their end of life.

Registry of Intention for PFAS restriction was announced by ECHA on 15th July 2021, to prepare a restriction proposal for PFAS. Fluoropolymers are also included in the scope. The restriction proposal is intended to be submitted to ECHA by 15th July 2022.

Fluoropolymers are a distinct subset of PFAS and are inherently safe, non-mobile, non-bio accumulative and non-toxic. Fluoropolymers are different from other PFAS as they **do not share the**

toxicological and environmental profiles associated with PFAS of concern. Fluoropolymers have **unique set of physicochemical properties,** they meet OECD polymer of low concern criteria, and are considered to have **insignificant environmental and human health impact**.

Fluoropolymers ensure safety, reliability, durability and critical performance in numerous technologies, industrial processes and everyday applications that are important for human health, safety, and the environment. With a unique combination of functionalities, fluoropolymers are irreplaceable across many key sectors/applications. Alternatives to fluoropolymers, if exist, escalate safety risks, carbon footprint, technology regression, and do not match the advanced performance of fluoropolymers. Most importantly, restriction on fluoropolymers will make EU industry lose its technological superiority over other economies and could put Europe's climate and energy goals at risk. Overall, fluoropolymers contribute heavily to Europe's socio-economic status and are critical for the betterment of the society.

The fluoropolymer downstream user industry acknowledges the concerns regarding PFAS emissions due to the use of fluoropolymers and end of life processes. We wish to assure the authorities and EU Member States that, we are implementing Best Available Technologies to ensure reduction in PFAS emissions in a systematic way and eventually eliminating them to achieve EU's sustainability goals. Parallelly, we are consciously working on recyclability and reusability to meet circular economy goal.

Fluoropolymers play an important role in achieving EU Green Deal objectives and UN Sustainable Development Goals (UN SDG) because of their vital use in Lithium-ion batteries, Green hydrogen, Fuel Cell, Solar and Wind energy. No new-age technologies are possible without the use of fluoropolymers. Restriction on the use of fluoropolymers would adversely impact implementation of these technologies crucial for planet's future as well as in all existing applications vital for the society.

Considering the benefits of fluoropolymer applications to environment and society, low PFAS emissions and initiatives being taken by the processing industry to further minimize emissions and closing the loop by implementing circular economy wherever possible, we request for a **complete exemption of fluoropolymers from the PFAS restriction proposal.**

Fluoropolymers processed by us: PTFE, PFA, FEP, PCTFE, PEEK

Service application industries:

Fluid Control, Medical, Chemical Process, Seals & Gaskets

Sincerely yours,

P6

Til