CASE STUDY

OCRA technology removes PFAS from industrial sewage

REMEDIATION PROJECT
Brisbane International Airport AFFF System Malfunction

MATERIAL
PFAS Contaminated Industrial Sewer, Estuarine Water & Industrial Cleaning Fluids

VOLUME
18+ Million Litres

PRINCIPAL
Airline Operator

LOCATION
Brisbane, Queensland, Australia

SUMMARY

Responding to an emergency request to remediate a PFAS impacted industrial sewer and surface water, EVOCRA rapidly deployed a mobile water treatment plant equipped to resolve the complex treatment challenge. The plant was required to manage significant inlet quality fluctuation and meet strict regulatory criteria for discharge to the local municipal utility.

Upon the safe and successful completion of the client's initial scope, without variations, the project was extended to PFAS impacted industrial cleaning fluids. All project expectations were met with treated materials discharged to contract specification and extracted PFAS concentrated for off-site destruction, removing the captured PFAS from the environment permanently.

SOLUTION

EVOCRA's innovative Ozofractionative Catalysed Reagent Addition (OCRA) technology for ozone foam fractionation reduced the PFAS into a concentrate of less than 1% of the original impacted volume. This reduction in volume conservatively saved the client an estimated $25M in water management costs. Subsequent improvements to the process have decreased the concentrate volume to less than 0.2%.

Utilising a single OCRA-PFAS process train, EVOCRA was able to successfully remove the bulk PFAS and biological load from industrial sewer, storm water, estuarine water, caustic solvent cleaning solutions and trade waste. This allowed processing by an RO-NF final polish system to meet the project discharge objectives.

EVOCRA's competitive OCRA technology, with its whole-of-project economic benefits and minimal footprint integrated into the clients workplace, allowing the client to maintain all core operations while meeting their remediation obligations.

RESULTS

OCRA consistently achieved treatment levels to below those of the local drinking water standards for PFAS. The average discharge quality for key PFAS compounds PFOA, PFOS and PFHxS was <0.01μg/L.

Combining OCRA with an RO-NF polishing unit reduced the total PFAS by over 99.9%, as measured via TOP Assay. The average sum of PFAS (TOP Assay) of 762μg/L in the influent was reduced to an average sum of PFAS (TOP Assay) of <0.56μg/L in the treated discharge water across the impacted sewage.

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ISSUE

Historical use of PFAS in aqueous film forming foam (AFFF), industrial surface coatings and other household products, coupled with their persistent nature and high mobility, has led to a widespread global problem. PFAS is a group of over 10,000 synthetic compounds, with current human health concerns dominated by specific compounds including PFOS, PFOA and others. Additionally, there is growing apprehension over the potential toxicity of many shorter chain PFAS precursor compounds.

Traditional adsorbent methods do not provide a complete solution for PFAS. Adsorbent media, such as ion exchange resins and activated carbon, primarily target specific compounds such as PFOS, PFOA, and other long chain PFAS. Limitations of adsorbent media include an inability to capture short chain PFAS, high susceptibility to fouling when exposed to biology, blinding of the resin by many co-contaminants and the generation of relatively large volumes of spent media that requires landfill disposal at specialised facilities.

OCRA offers a solution that produces clean treated water (>99.8%vol) and a PFAS concentrate (<0.2%vol). The concentrate is then sent for destruction, aligning with EVOCRA's commitment to removing PFAS from the environment.

EVOCRA has developed and successfully deployed its patented advanced bubble technology for removing PFAS and other contaminants from the environment. We strive to produce high quality treated water streams with whole-of-project cost efficacy. We have achieved drinking water PFAS specifications from complex co-contaminated fluids, without pre-treatment.

TECHNOLOGY

EVOCRA's patented OCRA process, marketed exclusively in North America by Ovivo, is a new generation technology that can be customized to meet the demands of the raw materials being treated. OCRA utilizes micro-bubbles of ozone in a multiphase process that provides great versatility for the removal of contaminants and sediments via oxidation-reduction, precipitation, electrostatic flotation and if required reagent absorption, dependent upon the chemical group and species of interest.

OCRA's vast gas-liquid interface elevates oxidation-reduction potential (ORP) conditions of the OCRA chambers, degrading organic co-contaminants including petroleum hydrocarbons, and persistent contaminants as well as transforming metal ions into stable compounds and facilitating bubble adhesion for PFAS compounds. Degraded or stabilized byproducts are captured and removed via a number of industry established methods, providing a high-quality treated water. Collected contaminants can either be destroyed or disposed externally or where possible beneficially reused on site.

OCRA's ability to carry out several extractive techniques within a single reaction vessel provides significant advantages in reducing overall footprint and cost.

PROCESS

The multiple foam fractionation columns of an OCRA-PFAS plant remove greater than 99.5% of regulated PFAS from raw influents. This arrangement also reduces the total measured PFAS concentration by more than 85%, in the treated water.

The OCRA process provides the following benefits:

- **Eliminates** down time from organic fouling due to its destructive treatment of almost all organic compounds.
- **Eliminates** process obstructions by removing suspended solids from the process fluid.
- **Reduces** the number of unit operations required for complex water contaminations by using the multifunction reaction chambers.
- **Reduces** waste volumes, which reduces on-site costs and external transport and disposal costs.
- **Recovers** resources, water and valuable minerals.
- **Reduces** reagent usage, by up to 75% in comparison to traditional methods. Reagents include adsorption media, if required for polishing to higher quality discharges.
- **Removes** contaminants from the environment eliminating risks to human health as well as other ecology.

APPLICATION

OCRA can be installed either as a stand-alone process, an upstream bulk cleansing process for ultra-trace polishing processes or as a (pre- or post-) bolt-on to existing infrastructure. This versatility minimizes any potential disruptions to present operations. OCRA plants are modular and can be scaled to meet any site requirements. OCRA is designed to be energy efficient, while the energized process fluid, produced in the high oxidation-reduction environment, increases reagent efficiencies.

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INTERNATIONAL AIRPORT — INDUSTRIAL SEWER 1, PFAS TREATMENT

CONTAMINANT	INFLUENT QUALITY	OCRA TREATED	PERCENT VARIANCE	POST NF/RO POLISH	PERCENT VARIANCE
STANDARD PFAS ANALYSIS					
PFBS	0.09 µg/L	0.20 µg/L	-122.2%	0.03 µg/L	66.7%
PFPeS	0.06 µg/L	0.02 µg/L	66.7%	< 0.01 µg/L	83.3%
PFHxS	0.34 µg/L	< 0.01 µg/L	97.1%	< 0.01 µg/L	97.1%
PFHpS	0.06 µg/L	< 0.01 µg/L	83.3%	< 0.01 µg/L	83.3%
PFOS	1.83 µg/L	< 0.01 µg/L	99.5%	< 0.01 µg/L	99.5%
PFBA	0.45 µg/L	3.32 µg/L	-637.8%	0.66 µg/L	-46.7%
PFPeA	1.57 µg/L	8.40 µg/L	-435.0%	1.30 µg/L	17.2%
PFHxA	2.86 µg/L	13.73 µg/L	-380.1%	2.12 µg/L	25.9%
PFHpA	0.57 µg/L	0.37 µg/L	35.1%	0.04 µg/L	93.0%
PFOA	0.72 µg/L	< 0.01 µg/L	98.6%	< 0.01 µg/L	98.6%
PFNA	0.11 µg/L	< 0.01 µg/L	90.9%	< 0.01 µg/L	90.9%
6:2 FTS	19.78 µg/L	0.19 µg/L	99.0%	0.06 µg/L	99.7%
8:2 FTS	2.58 µg/L	< 0.02 µg/L	99.2%	0.03 µg/L	98.8%
∑ PFAS*	30.69 µg/L	26.44 µg/L	13.8%	0.45 µg/L	98.5%
∑ PFAS**	31.02 µg/L	26.30 µg/L	15.2%	4.30 µg/L	86.1%
TOTAL OXIDISED PFAS ASSAY (TOPA) ANALYSIS					
PFBS (TOPA)	4.06 µg/L	0.47 µg/L	88.4%	< 0.01 µg/L	99.8%
PFPeS (TOPA)	4.05 µg/L	0.03 µg/L	99.3%	< 0.01 µg/L	99.8%
PFHxS (TOPA)	4.24 µg/L	< 0.01 µg/L	99.8%	< 0.01 µg/L	99.8%
PFHpS (TOPA)	4.05 µg/L	< 0.01 µg/L	99.8%	< 0.01 µg/L	99.8%
PFOS (TOPA)	5.45 µg/L	< 0.01 µg/L	99.8%	< 0.01 µg/L	99.8%
PFBA (TOPA)	106.81 µg/L	9.19 µg/L	91.4%	0.06 µg/L	99.9%
PFPeA (TOPA)	230.23 µg/L	20.46 µg/L	91.1%	0.02 µg/L	99.99%
PFHxA (TOPA)	131.28 µg/L	34.61 µg/L	73.6%	0.05 µg/L	99.96%
PFHpA (TOPA)	23.01 µg/L	0.70 µg/L	97.0%	< 0.01 µg/L	99.96%
PFOA (TOPA)	11.30 µg/L	0.02 µg/L	99.8%	< 0.01 µg/L	99.9%
PFNA (TOPA)	4.64 µg/L	< 0.01 µg/L	99.8%	< 0.01 µg/L	99.8%
6:2 FTS (TOPA)	122.39 µg/L	0.39 µg/L	99.7%	0.03 µg/L	99.98%
8:2 FTS (TOPA)	18.72 µg/L	0.04 µg/L	99.8%	0.03 µg/L	99.8%
∑ PFAS (TOPA)*	631.08 µg/L	66.09 µg/L	89.5%	0.08 µg/L	99.99%
∑ PFAS (TOPA)**	670.23 µg/L	65.95 µg/L	90.2%	0.27 µg/L	99.96%

* Total as reported by laboratory. ** Total sum of reported individual PFAS results (calculated).

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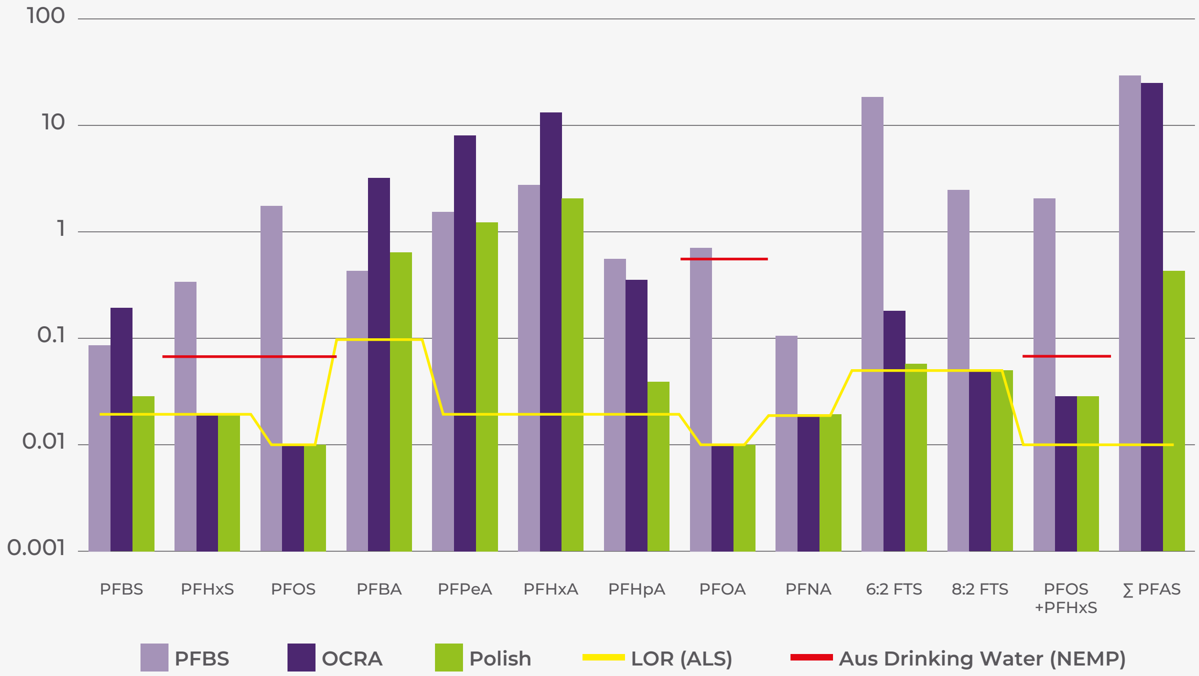
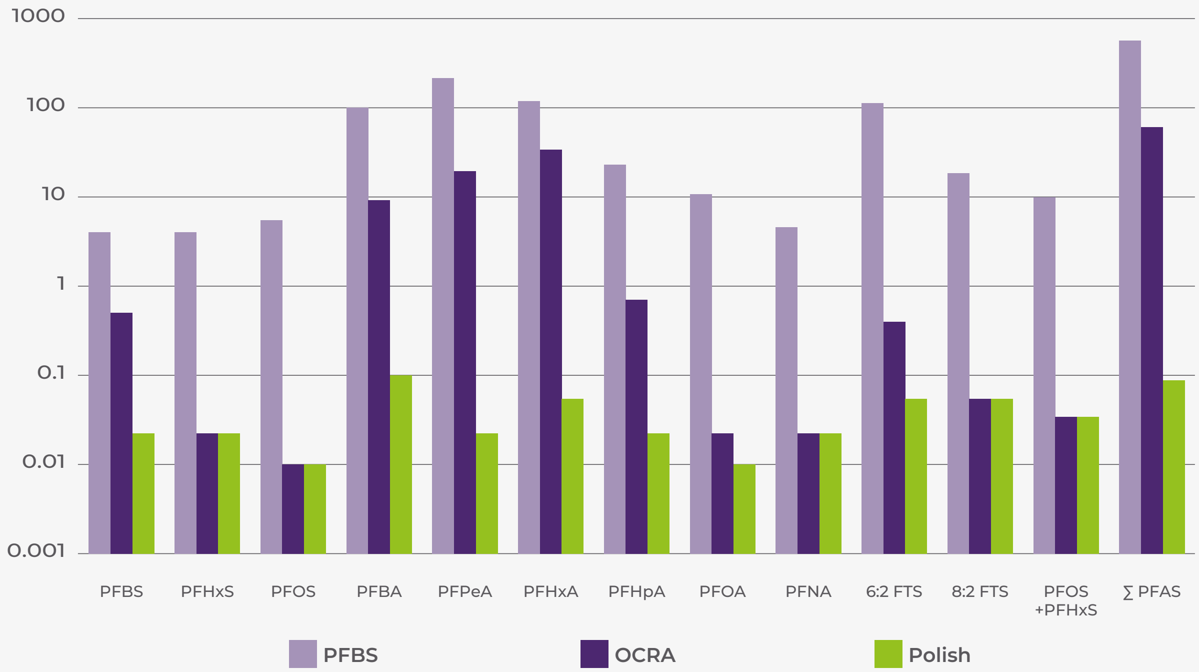
Reduction in PFAS Concentration via OCRA and then NF/RO **(TOP Assay PFAS Analysis)** Log Scale Plot



Reduction in PFAS Concentration via OCRA and then NF/RO **(Standard PFAS Analysis)** Log Scale Plot



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