# Evaluation of PFAS Removal Performance using Carbonit PFAS Filters in combination with the instrAction PFAS Absorber.

**April 2026**

# PART 1

# External Evaluation of PFAS Removal Performance using an Activated Carbon Block Filter, a Filter with a Functionalized Resin-based Material, and Hybrid Filtration Medias.

Conducted at the laboratory of the Institute for Sanitary Engineering, Water Quality and Waste Management (ISWA), University of Stuttgart

# Acknowledgement


- The study was conducted at the laboratory of the Institute for Sanitary Engineering, Water Quality and Waste Management (ISWA), University of Stuttgart by Dr. Ing. Behnam Askari Lasaki and Prof. Dr. Ing. habil. Harald Schönberger.

- TFA-Analytics were performed at Technologiezentrum Wasser (TZW) in Karlsruhe

- The study was commissioned by Carbonit GmbH, Salzwedel and instrAction GmbH, Heidelberg

# Introduction

Per- and polyfluoroalkyl substances (PFAS) are a class of persistent environmental contaminants that have gained increasing attention due to their widespread occurrence in water resources and their potential health impacts.

Particular concern is associated with:

- **Short-chain PFAS** (e.g., PFHxA, PFBS)
- **Ultra-short-chain PFAS**, especially **TFA**

These compounds are:

- Highly mobile in aquatic systems
- Difficult to remove using conventional treatment technologies
- Increasingly detected in drinking water sources

Activated carbon is widely used for PFAS removal but has known limitations, particularly for short-chain compounds. Recently, **functionalized resin-based materials** have been developed to enhance selectivity and removal efficiency.

This study aims to evaluate the resin-based filtration system from instrAction, the carbon-based filtration system from Carbonit, and the combined filter under realistic point-of-use conditions.

# Materials and Methods

**Test Location:** All experiments were conducted at the laboratory facilities of the Institute for Sanitary Engineering (ISWA), University of Stuttgart.

**Water Matrix:** The experiments were carried out using tap water with characteristics representative of Lake Constance (Bodensee) drinking water:

- pH ≈ 7.0
- Electrical conductivity ≈ 170 µS/cm
- Water hardness ≈ 8–12 °dH

**PFAS Preparation:** A mixture of PFAS compounds was **synthetically prepared and added** to an intermediate bulk container (IBC tank). The solution was thoroughly mixed to ensure homogeneous distribution before being introduced into the filtration system.

**PFAS Concentration:**

| | |
|---|---|
| • TFA (Trifluoroacetic acid) | 1.4 µg/l |
| • PFBS (Perfluorobutanesulfonic acid) | 0.3 µg/l |
| • PFHxA (Perfluorohexanoic acid) | 0.1 µg/l |
| • PFOA (Perfluorooctanoic acid) | 1.5 µg/l |

# Experimental Setup

**The experimental system consisted of:**

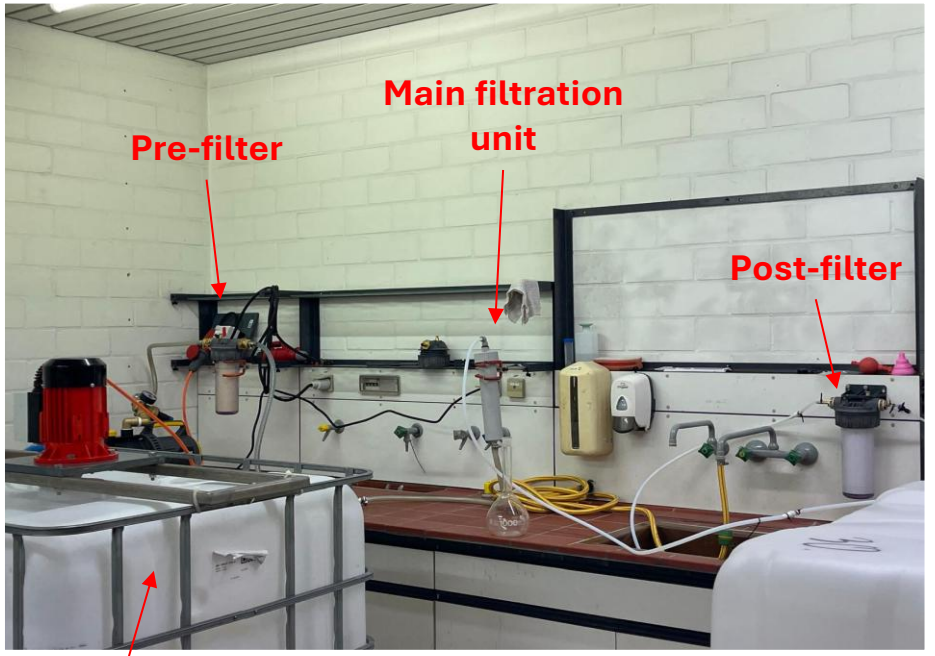
- IBC tank (feed solution)
- Mixing system
- Centrifugal pump
- Filtration columns
- Post-treatment unit

**Filtration configuration:**

- Pre-filter (1 µm) for particle removal
- Main filtration unit:
  - (A) Carbonit GFP Premium
  - (B) Carbonit ILP P200
  - (C) Carbonit GFP P200
- Post-filter prevent PFAS discharge into the laboratory drainage system

**Operating conditions:**

- Flow rate: 2.0 L/min
- Operation time: 8 hours/day
- Total loading: up to 3,000 Liter




Test Set-up at ISWA

# Filters examined

(A)

**Carbonit GFP Premium**

10“ activated carbon block with a pore size of 0.3 µm

(B)

**Carbonit ILP P200**

Radial flow filter with 330 ml of instrAction absorber resin P 200

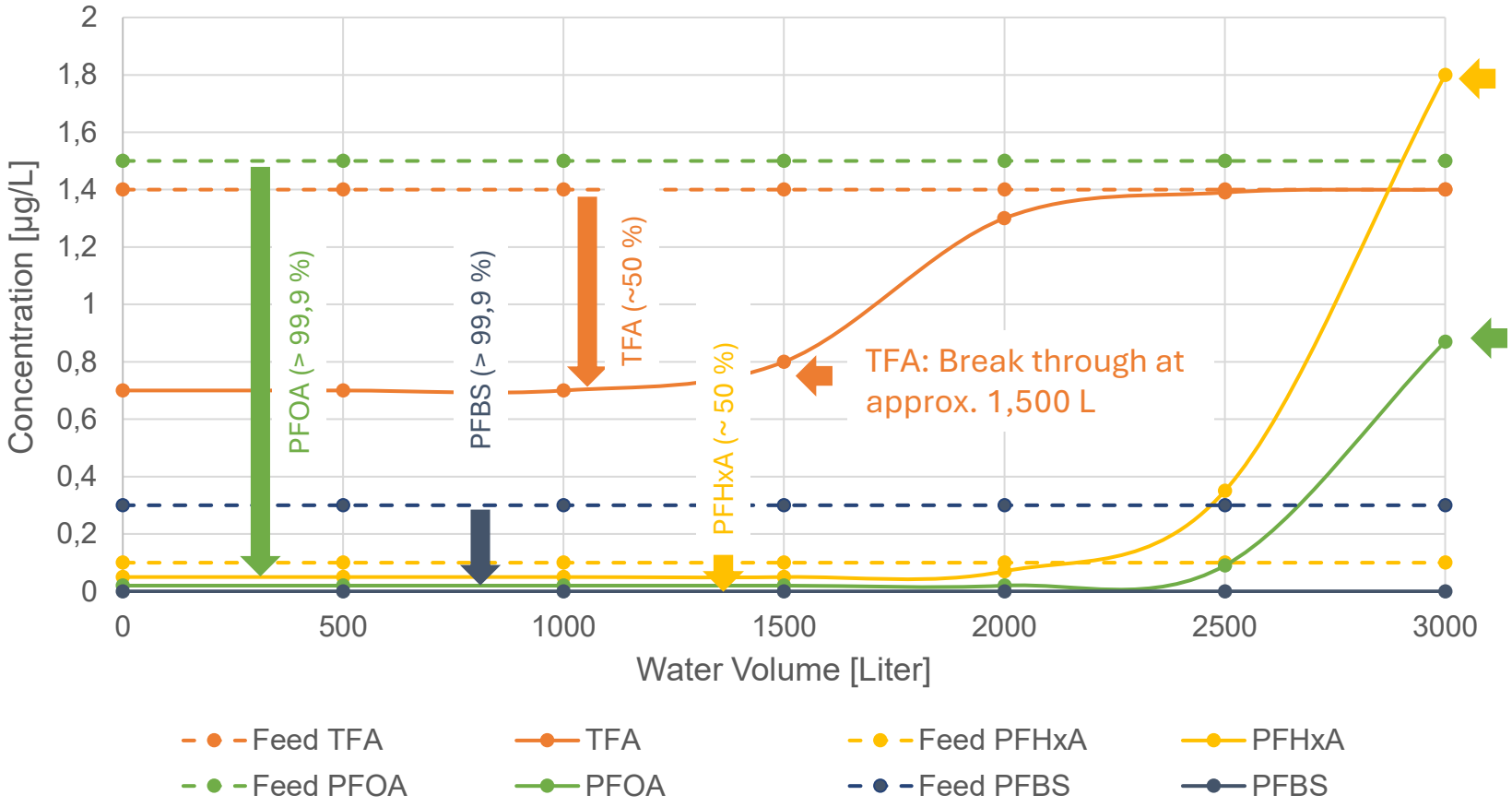
(C)

**Carbonit GFP P200**

10“ carbon block combined with instrAction absorber resin P 200

# Results: Test set-up (A)

## **Carbonit GFP Premium -** 10“ activated carbon block with a pore size of 0.3 µm




PFHxA: Break through at ~2000 L
Overshoot due to displacement by long-chain PFAS

PFOA: Break through at ~2500 L

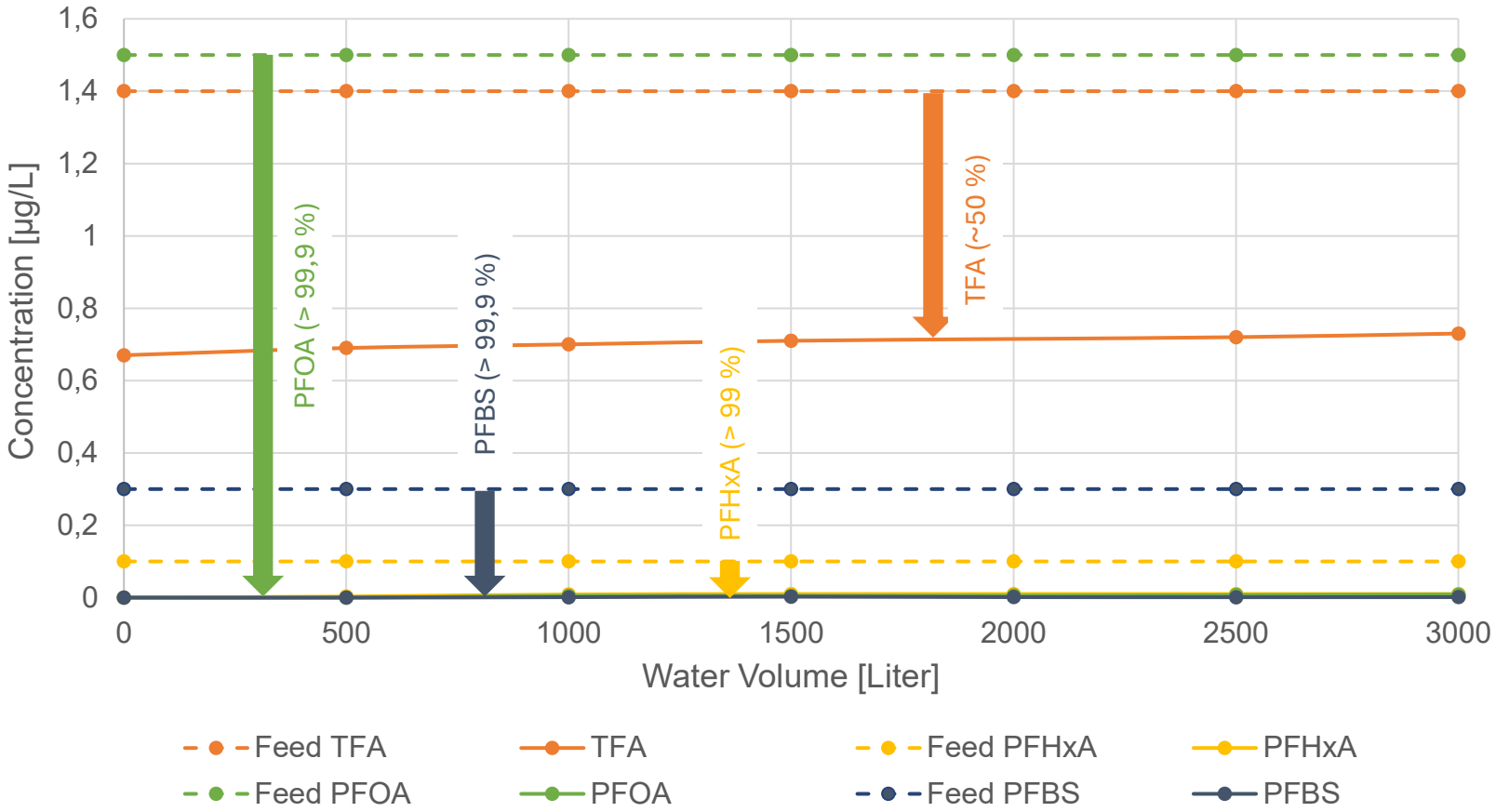
The graph shows the removal rates of the tested PFAS types over time.

- Early break-through of PFHxA and PFOA.
- A release of adsorbed PFHxA in favor of other PFAS.
- Complete removal of PFBS over the test period.
- After a removal rate of 50% for TFA an early break through at 1,500 L was observed.

Note: Analytical outliers were not considered and are not shown

# Results: Test set-up (B)

## **Carbonit ILP P200 -** Radial flow filter with 330 ml of instrAction absorber resin P 200



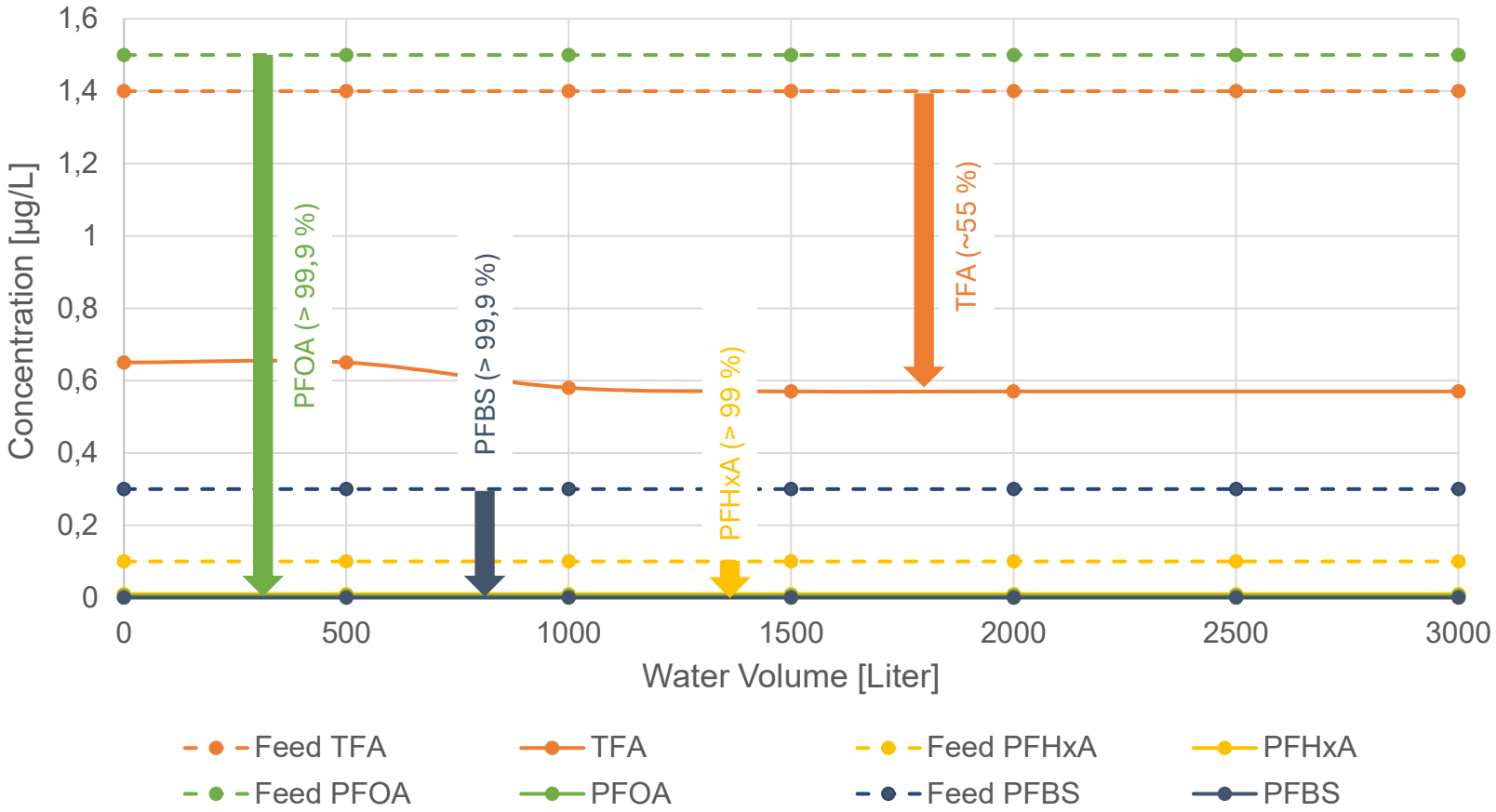

The graph shows the removal rates of the tested PFAS types over time.

- Constant removal rates.
- Complete removal of PFOA, PFHxA and PFBS.
- A removal rate of 50% was achieved for TFA over the entire run time.

Note: Analytical outliers were not considered and are not shown

# Results: Test set-up (C)

## **Carbonit GFP P200 -** 10“ carbon block combined with instrAction absorber resin P 200




Note: Analytical outliers were not considered and are not shown

The graph shows the removal rates of the tested PFAS types over time.

- Constant removal rates.
- Complete removal of PFOA, PFHxA and PFBS.
- A removal rate for TFA of above 55% was achieved over the entire run time.
- The combination of activated carbon and resin provides a synergistic effect: Carbon acts as a pre-conditioning stage and the resin provides selective absorption.

# Conclusions

This study demonstrates that:

- Functionalized resin-based materials provide improved removal performance, no evidence of breakthrough under examined water volumes (ca. 3.000 L) for short and long chain PFAS.
- TFA remains a major challenge due to its high mobility and low adsorption affinity, although an extent of removal of around 50% was observed when applying resin-based filters.
- Activated carbon alone shows limitations for PFAS removal under high flow rates.
- Hybrid systems offer a robust and effective solution for short and long-chain PFAS.
- The functionalized resin-based material exhibits higher selectivity and affinity toward PFAS compared to activated carbon, particularly for short-chain compounds.

These findings highlight the importance of **advanced treatment approaches** for PFAS removal in drinking water applications.

# PART 2

# Evaluation of PFAS Removal Performance according to NSF 53 protocol.

Conducted at the laboratory of instrAction GmbH, Heidelberg

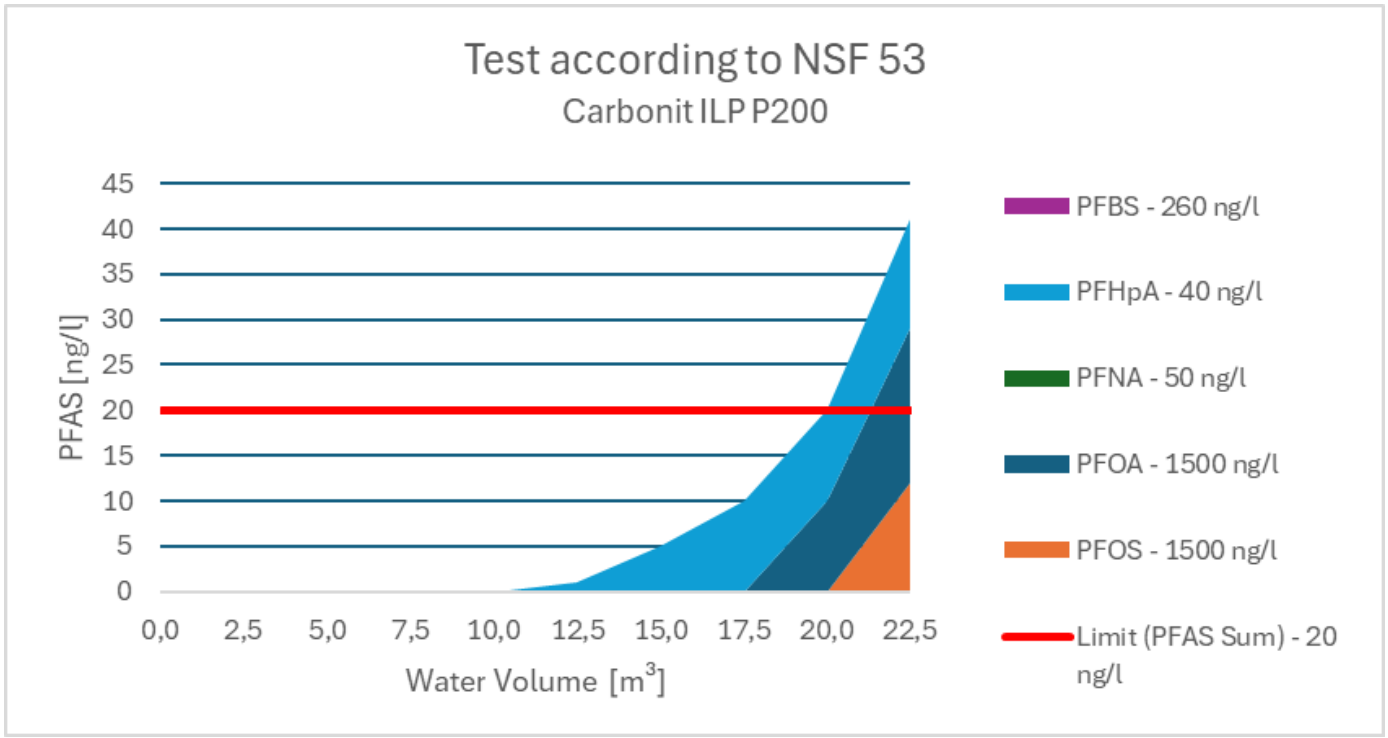
# PFAS removal efficiency – tested according to NSF 53 protocol

## Test Set-up

| | |
|---|---|
| Test Cartridge: | **Carbonit ILP P200 -** Radial flow filter with 330 ml of instrAction absorber resin P 200 |
| Absorber Volume: | 0,33 Liter |
| Absorber Resin: | instrAction P 200 |
| Particle Size: | 200 µm |
| Flow direction: | radial |
| Flow Rate: | 2,75 L/min (165 L/h; 262 BV/h) |
| Operation Time: | 8 hours/day |

| | | |
|---|---|---|
| Matrix: | Heidelberg tap water | |
| Feed: | PFOA | 1.500 ng/l |
| | PFOS | 1.500 ng/l |
| | PFNA | 50 ng{l |
| | PFHpA | 40 ng/l |
| | PFBS | 260 ng/l |
| | **PFAS Sum:** | **3.350 ng/l** |
| Limit after filtration: | | **20 ng/l** |
| Reduction Level: | 99,99% | |

# PFAS removal efficiency – tested according to NSF 53 protocol




The graph shows the removal rates of the tested PFAS types over time.

- As expected, PFHpA breaks through first, followed by PFOA PFOS third.
- The target limit of 20 ng/l was exceeded after 20 $m^3$ of treated water.
- This corresponds to approximately 63 mg of PFAS that was permanently bound to the absorber.
- According to NSF regulations, the following lifetime can be claimed:
  - With lifetime indicator: 16.000 Liters
  - W/o lifetime indicator: 10.000 Liters

**These results are unmatched on the market to date.**
**This makes it a unique offering and a unique selling point.**

# Contacts

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