

Technology for Waterworks

Adsorption and catalytic polishing stage for drinking water

Nanotechnology that extends the service life of activated carbon —
and addresses what conventional waterworks filtration was never designed to handle.

Product technical designation: AC Polish · adsorbent ART CARBON®

DANIEL-LM s.r.o. | AquaTech NorthBohemia Division

Compliance Is Not the Same as Absence

Waterworks lines were designed for turbidity, iron, manganese, microbiology and organic carbon. Trace substances at ng/l to µg/l concentrations were never part of that brief.

- **Pharmaceutical residues** — active compounds and metabolites entering source waters
- **Pesticides** — the most common reason a utility starts looking for a polishing stage
- **PFAS** — a group whose behavior differs sharply according to chain length
- **Microplastics** — only partially captured by conventional filtration
- **Biofilm in the network** — bacteria and viruses in deposits that disinfection reaches only to a limited degree
- **Disinfection by-products** — trihalomethanes formed by the reaction of chlorine with organics

Where the Stage Fits in the Line

Source → Pre-treatment → **Adsorption stage** → Chlorination → Distribution

The adsorption stage always goes before chlorination, never after it. The material is catalytically active and would decompose combined chlorine. This is a fixed design condition, not a recommendation.

- The existing line stays in place — one process unit is added, not a rebuild of the plant
- Can be installed in series ahead of existing activated-carbon filters, extending the interval between reactivations
- Pre-treatment (sedimentation, filtration of solids) is a condition, not an optional add-on

Value for the Operator



Fast kinetics

Adsorption on the outer surface of the nanotubes as well as inside the aggregate, which means a smaller installation footprint.



No reactivation logistics

The adsorbent stays in the column and is regenerated in place. There is no removal, no transport to a reactivation facility and no replacement cycle tied to it. Regenerated material reached 92–100% of the performance of new material at ten minutes of contact.



Regeneration without shutdown

A stage is valved off and regenerated while the remaining stages stay in full operation.



Passive antimicrobial effect

The material provides no growth medium for bacteria and forms no biofilm.



Modular design

Number of stages and diameter set by the water, not by a catalog.



Selective modification

The nanotubes can be modified for a specific target pollutant.



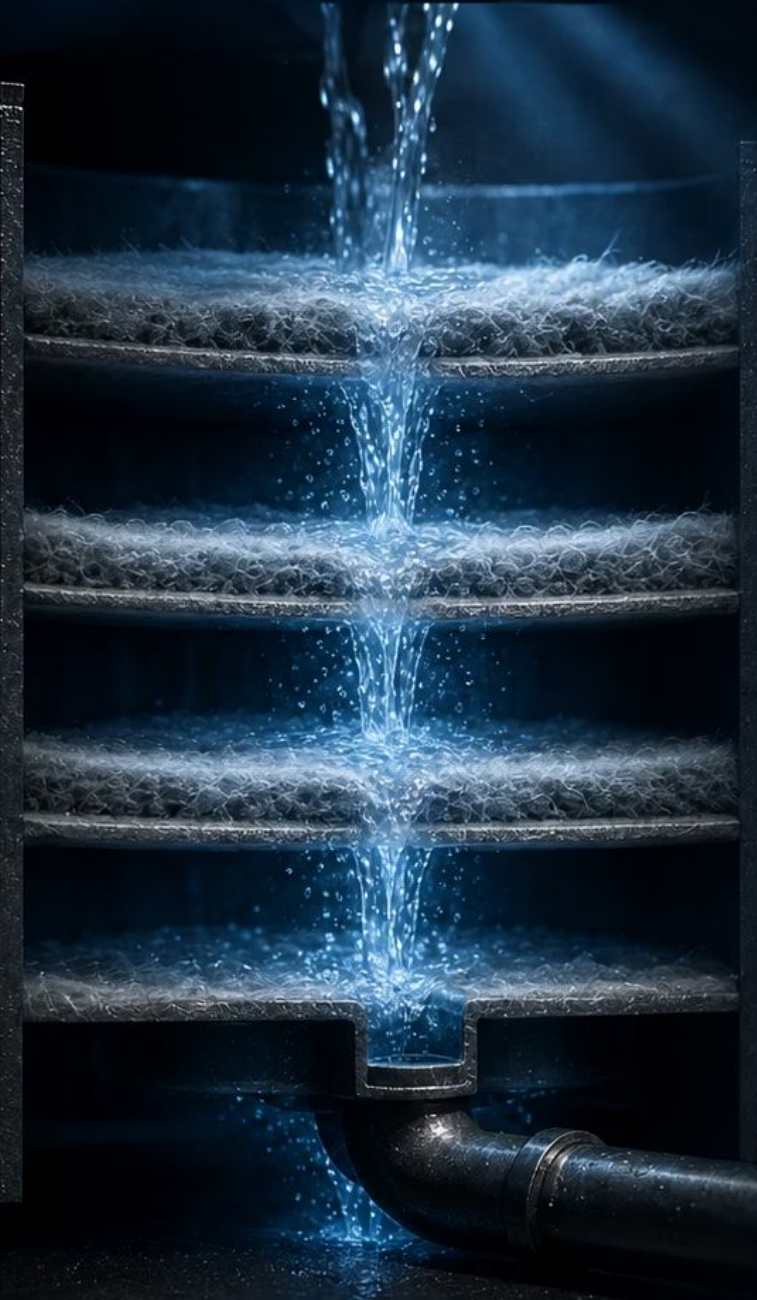
Why Faster Than Granular Activated Carbon

Paired comparison — the same water, the same protocol, the same contact time for both materials. Contact time is stated for every pair, because it is the variable that decides the outcome.

• Naproxen	30 s	ART CARBON®	>91%	Granular activated carbon	0%
• Carbamazepine	2 min	ART CARBON®	93%	Granular activated carbon	8%
• Metoprolol	5 min	ART CARBON®	97%	Granular activated carbon	9%
• Simazine	5 min	ART CARBON®	96%	Granular activated carbon	1%

Source: TU Liberec, batch sorption tests. Pre-treated surface water fortified with four micropollutants at 1 µg/l each. Sampling at 0.5, 2, 5, 10 and 20 minutes. For reference: granular activated carbon reached a maximum of 36% on simazine at 20 minutes — a contact time no full-scale line operates at.

Stated separately. At ten minutes of contact, granular activated carbon reaches 12–47% of the ART CARBON® performance. This is a ratio between two materials at one contact time, not a removal rate — which is why it is never plotted on an absolute axis.



How It Works

Water enters the top of each stage, passes through the adsorbent supported on a filter fabric over a false bottom, and drains into the collection pipework.

1.

Adsorption — Contaminants are captured on the outer surface of the nanotubes and inside the aggregate. Residence time 1–5 minutes depending on concentration, capacity and target performance.

2.

Catalysis — The material also acts as a catalyst and enables the breakdown of certain substances. The breakdown can be induced with auxiliary oxidizing agents.

3.

In-situ regeneration — Each stage can be isolated with valves and regenerated separately while the rest of the assembly stays in operation, using a dedicated ethanol-based reagent, pH 12, 30 min, 35 °C.

Regeneration can be carried out stage by stage across the entire adsorption-catalytic assembly. A regeneration kit and a regenerate-recycling module can be supplied as part of the delivery.

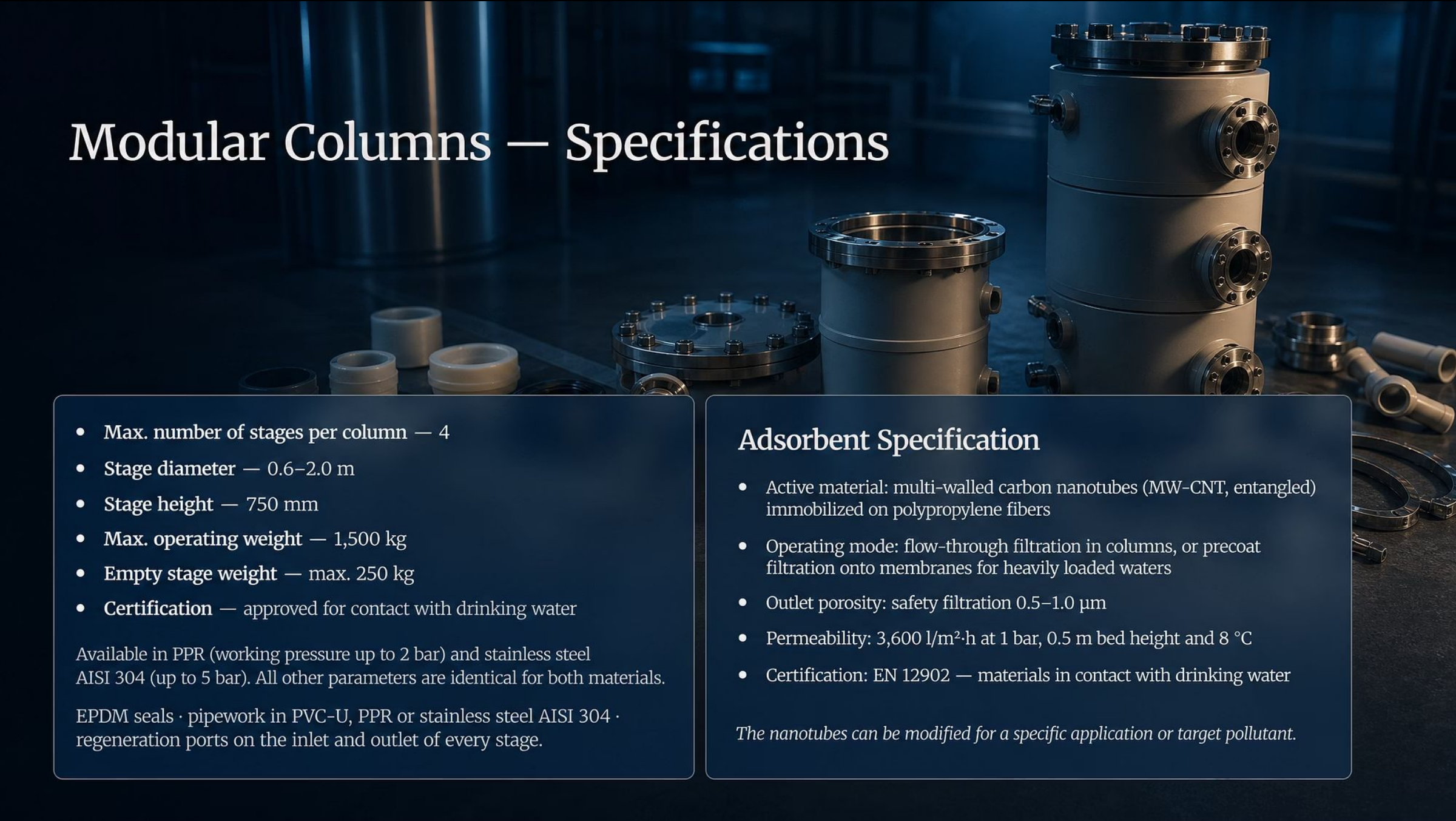
The background image shows three large, vertical, cylindrical stainless steel adsorption columns in an industrial setting. The columns are arranged in a row, with various pipes, valves, and flanges visible. The floor is wet and reflective, and the lighting is dramatic, with strong highlights and shadows.

Operating Characteristics

- **Operating capacity** — typically 1–400 m³/h depending on the column assembly
- **Temperature** — 2–40 °C
- **pH** — 2–12
- **Adsorption capacity** — 10–120 mg/g depending on contaminant type
- **Residence time** — 1–5 minutes depending on concentration and target performance
- **Regeneration** — in situ, without removing the adsorbent from the column
- **Intermittent operation** — permitted; no sanitization required during shutdown
- **Chemical tolerance** — no limitations, provided the adsorbent is not fouled by mechanical particles

That last row is precisely why the adsorption stage always follows standard pre-treatment.

Modular Columns — Specifications

The background image shows several industrial-grade modular filtration columns of different heights and diameters, along with various fittings, flanges, and pipe sections. The components are arranged on a dark, reflective surface, with some parts illuminated by blue and white spotlights, creating a high-tech, industrial atmosphere.

- **Max. number of stages per column** — 4
- **Stage diameter** — 0.6–2.0 m
- **Stage height** — 750 mm
- **Max. operating weight** — 1,500 kg
- **Empty stage weight** — max. 250 kg
- **Certification** — approved for contact with drinking water

Available in PPR (working pressure up to 2 bar) and stainless steel AISI 304 (up to 5 bar). All other parameters are identical for both materials.

EPDM seals · pipework in PVC-U, PPR or stainless steel AISI 304 · regeneration ports on the inlet and outlet of every stage.

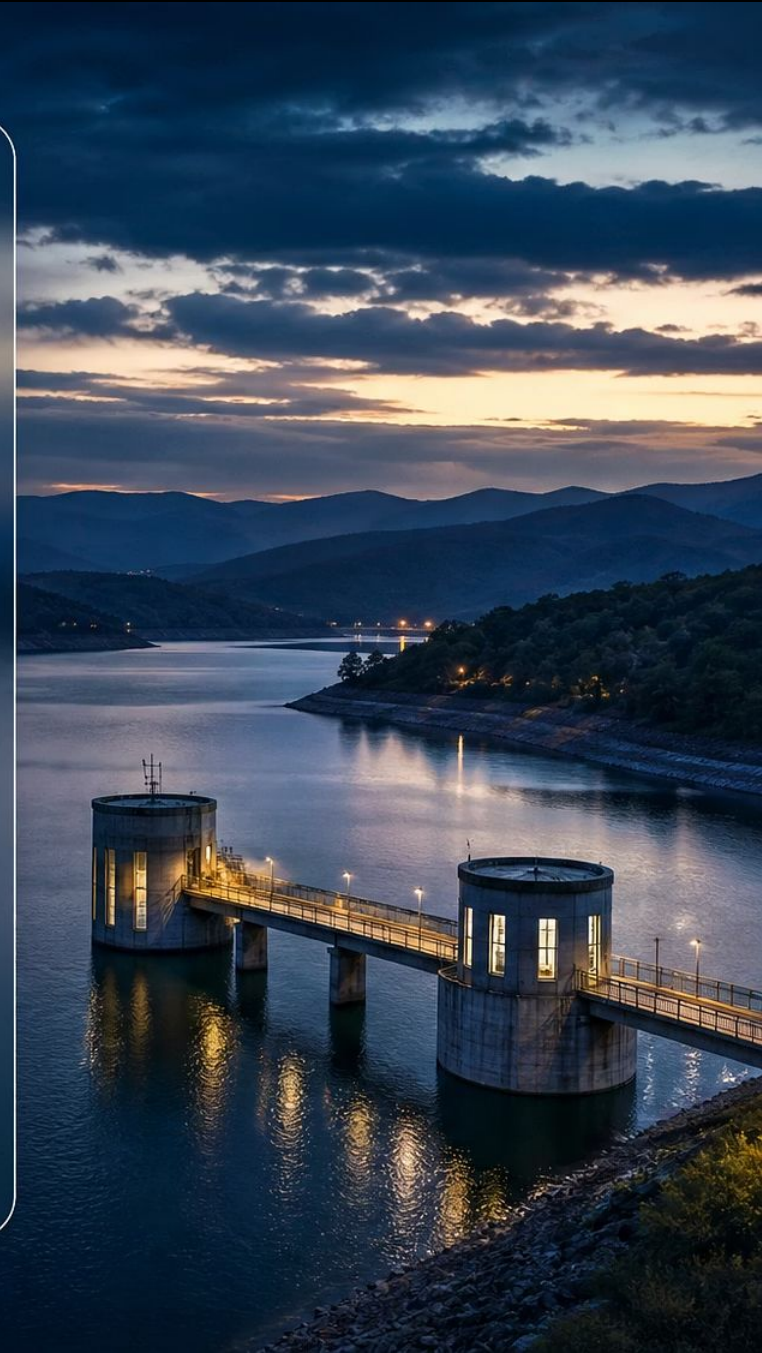
Adsorbent Specification

- **Active material:** multi-walled carbon nanotubes (MW-CNT, entangled) immobilized on polypropylene fibers
- **Operating mode:** flow-through filtration in columns, or precoat filtration onto membranes for heavily loaded waters
- **Outlet porosity:** safety filtration 0.5–1.0 μm
- **Permeability:** 3,600 l/m²·h at 1 bar, 0.5 m bed height and 8 °C
- **Certification:** EN 12902 — materials in contact with drinking water

The nanotubes can be modified for a specific application or target pollutant.

Applications in Water Supply

- Removal of organic micropollutants from raw and treated water
- Pre-treatment of water for reverse osmosis
- Extending the service life of existing granular activated carbon
- Recycling of sand-filter backwash water — a direct saving of raw water
- Protection of desalination membranes against fouling
- Smaller assemblies for municipalities with their own source and reservoir



Our Position on PFAS

ART CARBON® adsorbs long-chain PFAS (PFOA, PFOS) — we have point data, not breakthrough curves. For short-chain and ultra-short-chain compounds including TFA, adsorption on a carbon-based medium is fundamentally limited; for this group we propose an ART CARBON® plus targeted ion-exchange configuration. Breakthrough curves and design parameters for a specific water are established within a paid pilot.

- We do not state a removal percentage for PFAS until we hold a protocol for that particular water
- We never claim "removes PFAS" without distinguishing chain length
- The ion-exchange stage is replaced and disposed of once saturated — it is not regenerated
- The closed regeneration loop applies to the adsorbent, not to the ion exchanger — so we do not describe the PFAS solution as waste-free

A declared limit of applicability is a stronger position in a tender than a claim the competition can disprove.

Honestly — What We Do Not Promise

The adsorption stage is a polishing and catalytic element of the line, not a universal standalone solution.

- Requires standard pre-treatment — sedimentation and filtration of solids — and builds on it
- The number of stages and the column diameter always follow the actual composition of the inlet water
- Without a water analysis no figure can be promised; performance for a given site is established by assessment
- Does not replace disinfection — hygienic protection of the distribution network remains with the chlorination downstream of the stage
- The passive antimicrobial effect is documented by testing, but this is not a disinfection device
- Regeneration produces a liquid regenerate. This is a waste stream that has to be handled — a recycling module reduces its volume, but we do not describe the process as waste-free

The material is certified for contact with drinking water under EN 12902.

Verified in Operation



0.173 → 0,000 µg/l ·
Pesticides, inlet to outlet

Bezdědice waterworks, 2021 — one of four sampling rounds in operation on real raw water.



100 → 0 MPN/100 ml ·
E. coli, inlet to outlet

Microbiological protocol, VŠCHT Prague 2022 — remediation of a flooded well. Coliforms fell from 20,050 to 12 MPN/100 ml in the same sample.



No culturable bacteria ·
After 1,000 l and 14 days standing

Comparative test, TU Liberec 2023. Conventional activated carbon showed significant contamination after the same standing period.

References in Operation

- Denmark — pilot operation at an international partner in water technologies
- Bezdědice waterworks — removal of pesticides from drinking water
- Beverage production plant — removal of pesticides from bottled water at a multinational company

From Assessment to Operation

1. Technical and economic assessment with design options
 2. Laboratory verification on a sample of your water
 3. Pilot operation — breakthrough curve and media capacity
 4. Documentation for the design engineer, CAPEX and OPEX
 5. Drawings and technical documentation for a grant application
 6. Installation, trial operation and handover
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The first two steps are offered as a non-binding assessment with no contractual commitment. We are licensed to carry out this type of construction work and cooperate with design offices familiar with our technologies.



Which Substances Is Your Plant Dealing With?

Send your latest water analysis and basic operating data. We will propose the next technical step — a laboratory assessment, a pilot, or a preliminary technical and economic study.

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This material is intended for public presentation of the technology. It is not design documentation and not a performance guarantee for any given type of water. A specific design requires a water analysis and project assessment.