

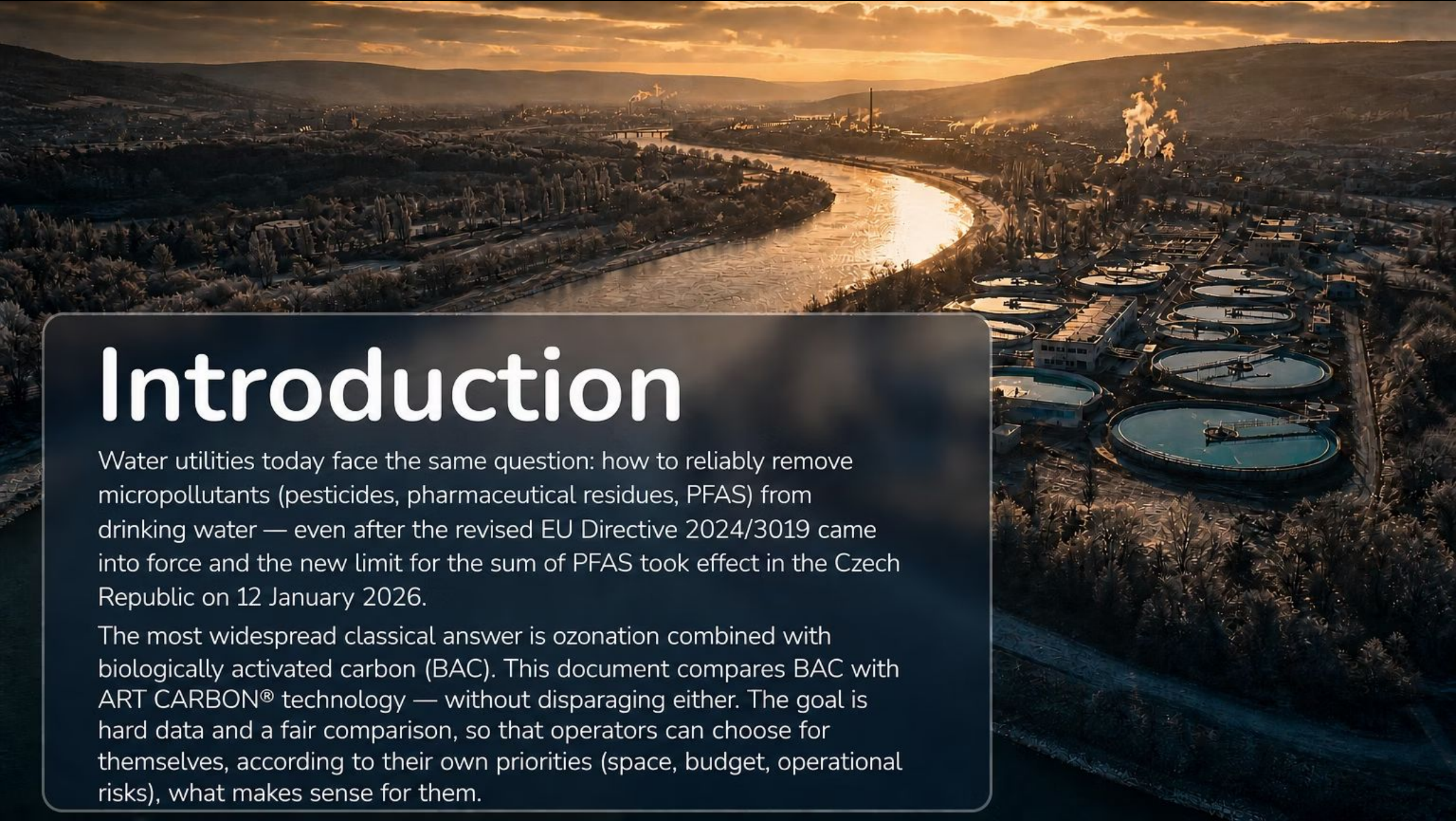
# BAC vs. ART CARBON®

Two paths to water polishing — explaining the principle, comparison, and what it means in operation

A technical, easy-to-understand guide for water treatment technologists and decision-makers

DANIEL-LM s.r.o. — AquaTech North Bohemia Division



An aerial photograph of a river winding through a landscape. On the right bank, there is a large industrial facility with several tall smokestacks emitting plumes of white smoke. In the foreground on the right, a wastewater treatment plant is visible, featuring several large, circular, blue-tinted aeration tanks. The river reflects the warm, golden light of the setting or rising sun. The background shows rolling hills under a sky with scattered clouds.

# Introduction

Water utilities today face the same question: how to reliably remove micropollutants (pesticides, pharmaceutical residues, PFAS) from drinking water — even after the revised EU Directive 2024/3019 came into force and the new limit for the sum of PFAS took effect in the Czech Republic on 12 January 2026.

The most widespread classical answer is ozonation combined with biologically activated carbon (BAC). This document compares BAC with ART CARBON® technology — without disparaging either. The goal is hard data and a fair comparison, so that operators can choose for themselves, according to their own priorities (space, budget, operational risks), what makes sense for them.

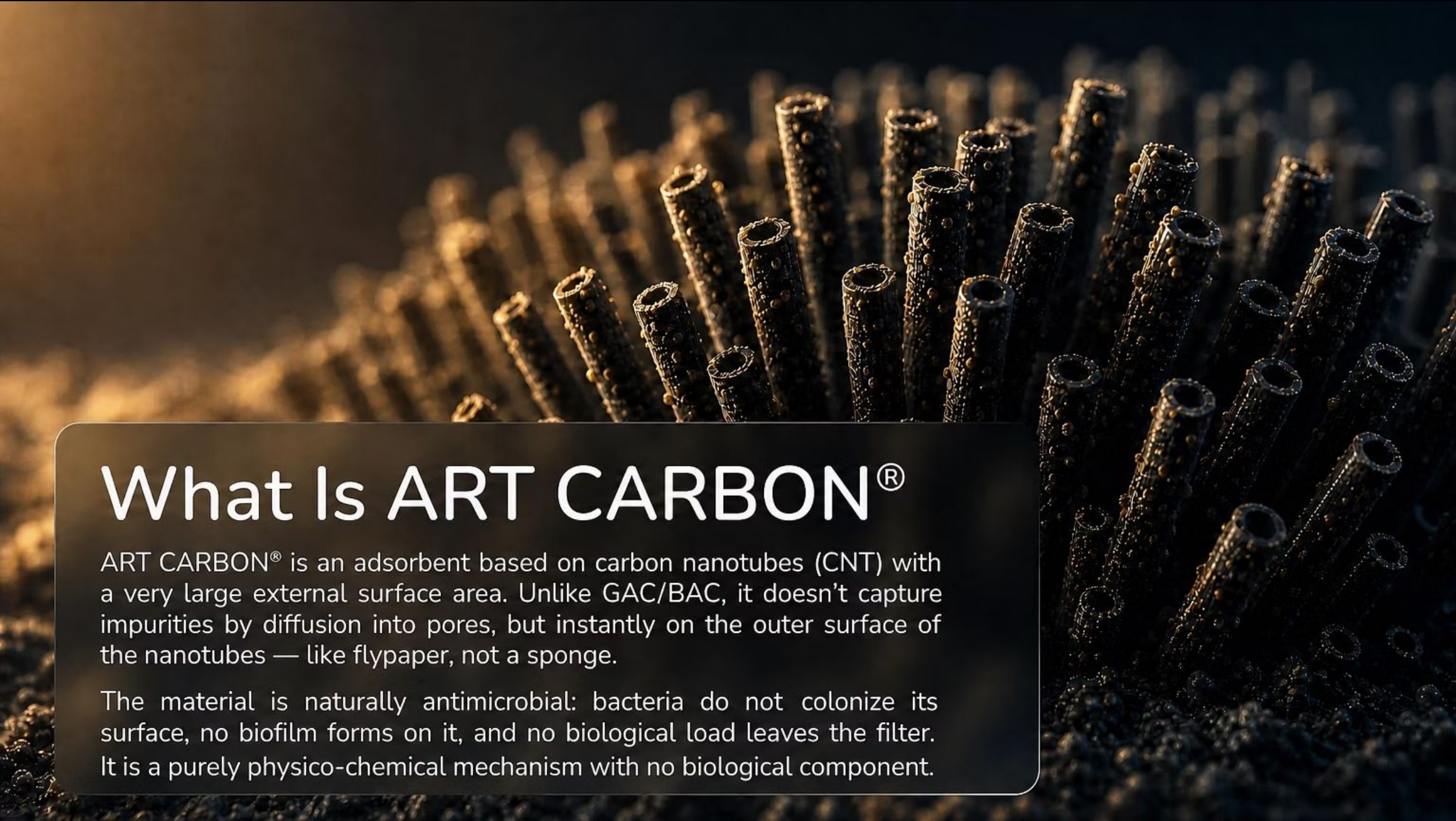
# What Is Biologically Activated Carbon (BAC)

Picture classical granular activated carbon (GAC) as an extremely porous black sponge that physically binds impurities from the water. As the sponge is used, its surface gradually clogs and its capacity is used up.

That's when nature steps in: bacteria naturally present in the water colonize the exhausted carbon and form a stable coating on it — biofilm. At that moment, ordinary carbon becomes biologically activated carbon (BAC), essentially a living filter.

1. **Physical capture (adsorption):** the carbon acts as a magnet that impurities stick to.
2. **Biological breakdown (biodegradation):** bacteria in the biofilm gradually decompose the trapped impurities into harmless substances (CO<sub>2</sub> and water).





# What Is ART CARBON®

ART CARBON® is an adsorbent based on carbon nanotubes (CNT) with a very large external surface area. Unlike GAC/BAC, it doesn't capture impurities by diffusion into pores, but instantly on the outer surface of the nanotubes — like flypaper, not a sponge.

The material is naturally antimicrobial: bacteria do not colonize its surface, no biofilm forms on it, and no biological load leaves the filter. It is a purely physico-chemical mechanism with no biological component.

# Part II — What Additional Technology BAC Needs

BAC alone is not sufficient for many of today's micropollutants. In practice, BAC is therefore always integrated into a chain with three additional steps:

- **Ozonation before BAC:** ozone breaks large, resistant molecules down into smaller, biologically digestible fragments.
- **Mechanical post-filter / ultrafiltration (UF) after BAC:** captures fragments of biomass before the water continues.
- **Strong final disinfection (chlorine / UVC):** thorough disinfection against any microorganisms that may have passed through the filter.

The result is four interdependent operational steps, where the failure of one (e.g. ozonation) disrupts the function of the entire chain. ART CARBON® only needs ceramic ultrafiltration ahead of it and the adsorption itself — two steps.



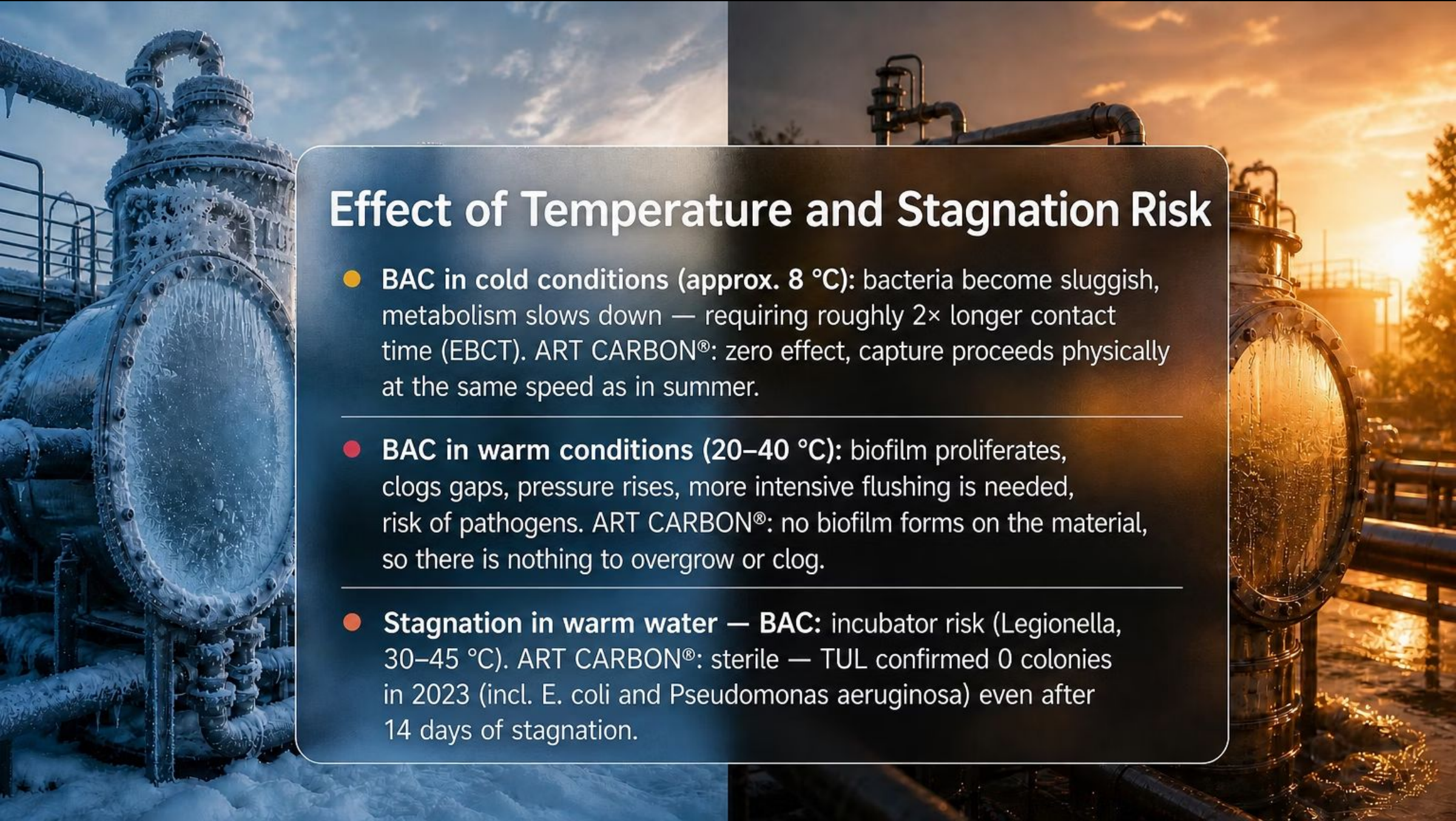
# Capture Speed (Kinetics) and Space Requirements

Independent tests by the Technical University of Liberec (TUL) at the same contact time:

- Naproxen — 30 s: ART CARBON® >91% | GAC/BAC 0%
- Carbamazepine — 2 min: ART CARBON® 93% | GAC/BAC 8%
- Metoprolol — 5 min: ART CARBON® 97% | GAC/BAC 9%
- Simazine — 5 min: ART CARBON® 96% | GAC/BAC 1%
- Simazine (GAC, extended contact) — 20 min: max. 36%

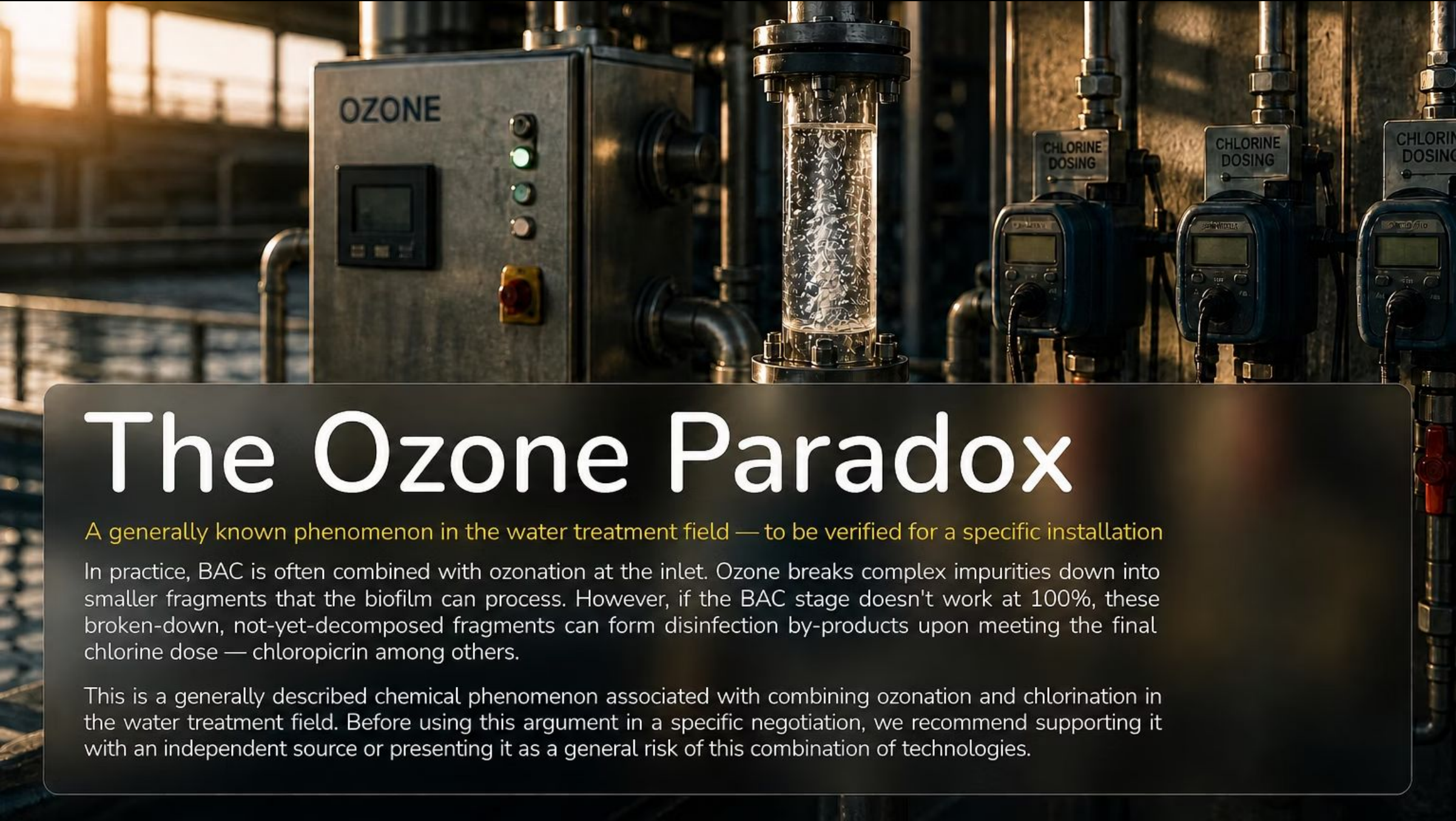
The indicative BAC contact time is 5–10 minutes, versus seconds to a few minutes for ART CARBON® — at the same flow rate, this range implies a roughly 10–20× larger required BAC bed volume.





## Effect of Temperature and Stagnation Risk

- **BAC in cold conditions (approx. 8 °C):** bacteria become sluggish, metabolism slows down — requiring roughly 2× longer contact time (EBCT). ART CARBON®: zero effect, capture proceeds physically at the same speed as in summer.
- **BAC in warm conditions (20–40 °C):** biofilm proliferates, clogs gaps, pressure rises, more intensive flushing is needed, risk of pathogens. ART CARBON®: no biofilm forms on the material, so there is nothing to overgrow or clog.
- **Stagnation in warm water — BAC:** incubator risk (Legionella, 30–45 °C). ART CARBON®: sterile — TUL confirmed 0 colonies in 2023 (incl. E. coli and Pseudomonas aeruginosa) even after 14 days of stagnation.



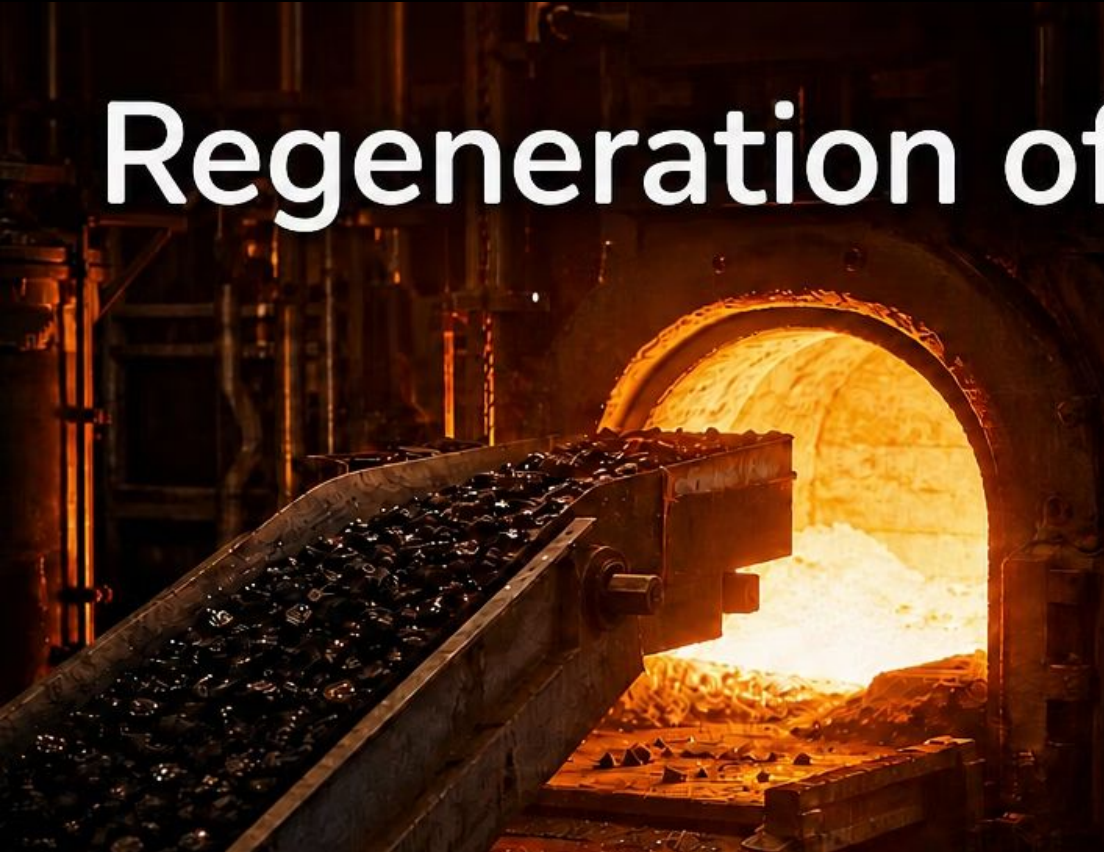
# The Ozone Paradox

A generally known phenomenon in the water treatment field — to be verified for a specific installation

In practice, BAC is often combined with ozonation at the inlet. Ozone breaks complex impurities down into smaller fragments that the biofilm can process. However, if the BAC stage doesn't work at 100%, these broken-down, not-yet-decomposed fragments can form disinfection by-products upon meeting the final chlorine dose — chloropicrin among others.

This is a generally described chemical phenomenon associated with combining ozonation and chlorination in the water treatment field. Before using this argument in a specific negotiation, we recommend supporting it with an independent source or presenting it as a general risk of this combination of technologies.

# Regeneration of Saturated Material



## Regeneration of BAC / GAC

The exhausted carbon is extracted, transported to a reactivation furnace, and burned off at 700–900 °C. During the process, 5–15 % of the carbon is irreversibly destroyed and must be replaced with new material.



## Regeneration of ART CARBON®

Takes place in-situ — directly in the column, without removing the adsorbent. In our drinking water treatment application: a rinse with an ethanol solution at pH 12, 35 °C, for approx. 30 minutes. The resulting regenerate is passed through RO: ~90 % of the volume returns to the process, ~10 % forms a liquid concentrate for disposal. No transport or incineration involved.

# Summary Comparison

- Capture principle — BAC: diffusion into internal pores + biological breakdown | ART CARBON®: instant capture on the outer surface of the nanotubes (purely physical)
- Additional stages — BAC: ozonation + post-filtration/UF + strong disinfection (4 interdependent steps) | ART CARBON®: ceramic UF + adsorption (2 steps)
- Contact time / space — BAC: minutes; roughly 10–20× larger bed volume | ART CARBON®: seconds to a few minutes
- Cold (8 °C) — BAC: 2× longer contact time | ART CARBON®: no change
- Heat / stagnation — BAC: risk of biofilm and pathogen overgrowth | ART CARBON®: sterile, no biofilm
- Regeneration — BAC: 700–900 °C, transport, 5–15% loss | ART CARBON®: in-situ solution at 20–40 °C, no transport



## Being Honest — What Does Not Follow from the Comparison & Verified in Practice

- Figures marked as 'to be verified' (100× and chloropicrin) are illustrative calculations from extreme values — not direct measurements on one and the same water.
- BAC + ozonation is a technology with a long operational track record and works reliably in many installations.
- Bezdědice water utility — real operational sampling, four measurements in 2021 (e.g. 0.173 → 0.000 µg/l).
- Zvírotice / Osečany — pilot verification on real water, efficacy on total pesticides tracked over time.
- TUL, January 2023 — zero bacterial contamination even after 14 days of stagnation, unlike competing filters.
- Atest Labtech s.r.o. — the adsorbent meets the requirements of Decree No. 409/2005 Coll. (protocol PSV 08A/2020, January 2023).



# Contact

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