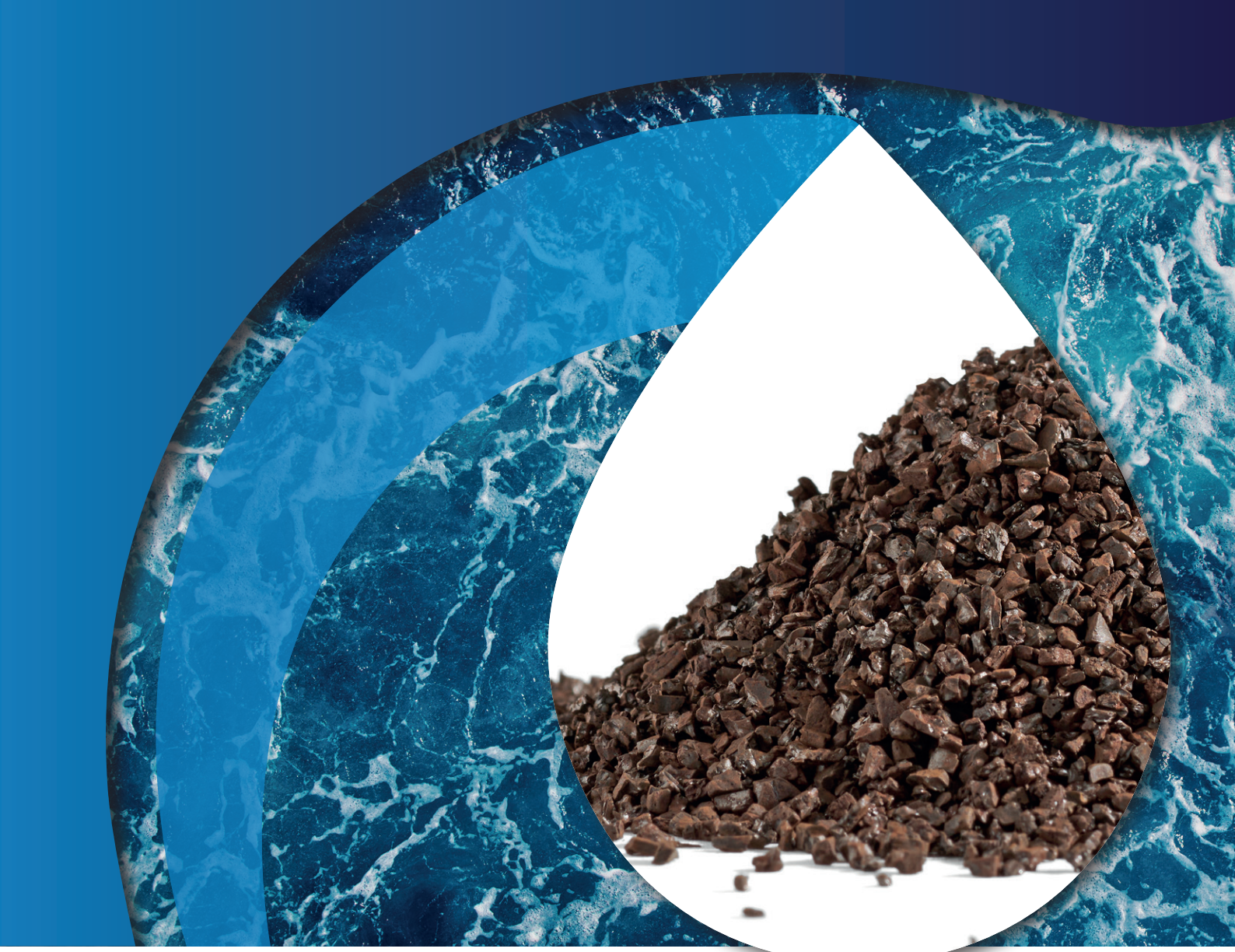


BluAct Granulated Materials

Remove Heavy Metal Ions and Multiple Chemicals from Water.

ENWOTEC
FILTRATION & PROCESS CONSULTING

BluAct Technologies

BluAct Granulated Materials

The granulated material (GraPro) is made from protein fibers and activated porous carbon and can be used to remove heavy metal ions and multiple per- and polyfluoroalkyl substances (PFAS) from water.

During water passage through this media in the fixed bed reactor, the concentration of heavy metal ions and PFAS drops down with efficiency higher than 99%. The filtration process can be repeated numerous times. Notably, the efficiency remains unaltered when filtering several ions simultaneously. The performance of the media is enabled by the ability of the protein fibers to non-selectively absorb heavy metal pollutants and PFAS from solutions, without affecting the healthy mineral composition of water.

The dimension of the granules can be tuned to various size ranges. These hybrid granules are used as the main adsorbing media to remove a wide range of pollutants for surface and ground water, industrial large-scale water treatment applications and drinking water. GraPro 2.2 is a special version to treat water additionally contaminated by arsenic.

Composition of the media

- Activated carbon
- Fibril based on milk protein (β-lactoglobulin) or other proteins
- Available on request with other proteins

Key benefits

- Multiple pollutants removal
- High retention of heavy metals
- Absorbs radioactive and PFAS substances
- Fits in any already existing fixed bed reactor
- Available for small quantities
- Universally applicable
- Any size scalable
- Gravity filtration, without any energy requirement

Broad Range Pollutants removal

GraPro compared to other technologies

Technology	MF	UF	Activated Carbon	Iron-based adsorbent	Ion exchange resins	NF	RO	BluAct GranPRO
Bacteria	✔	✔	✘	✘	✘	✔	✔	✔
Suspendid solids	✔	✔	✘	✘	✘	✔	✔	✔
Organic pollutants	✘	✘	✔	✘	✘	✔	✔	✔
Heavy metal ions	✘	✘	✘	✔	✘	✔	✔	✔
No change in healthy minerals ions composition	✔	✔	✔	✔	✘	✔	✘	✔
Low energy consumption	✔	✘	✔	✔	✔	✘	✘	✔
Water recovery efficiency	✔	✔	✔	✔	✔	✔	✘	✔

Efficiency

Removal Efficiencies

Natural and waste-water heavy metals

Arsenic (V & III)	99.9 %
Lead	99.9 %
Mercury	99.5 %
Nickel	99.8 %
Chromium	99.2 %
Aluminium	98.0 %

Radioactive Pollutants

Technetium (Tc-99m)	99.9 %
Iodine (I-123)	99.9 %
Gallium (Ga-68)	99.8 %
Lutetium (Lu-177)	99.9 %
Iodine (I- 131)	99.9 %
Uranium	99.3 %
Cesium (Cs-137)	99.7 %
Phosphorous (P-32)	99.8 %

Precious metals removal and recovery

Gold cyanide and chloride	99.6 %
Platinum	99.9 %
Silver	99.8 %
Palladium	99.8 %

Organic Pollutants

Acetoamenophene	99.9 %
Desethylatrazine	99.9 %
Acesulfame	99.9 %

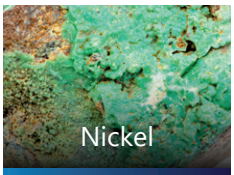
Other Pollutants

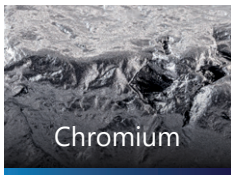
Fluoride	99.5 %
PFAS and Micropollutants	> 97.0 %

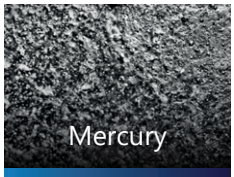
Also efficient in removal of Vanadium, Molybdenum, Antimony, Zinc, Hydrogen sulfide, Phosphate, Silicates, Copper and wide range of organic pollutants (pesticides, pharmaceuticals)

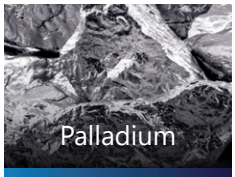
NSF53 standards

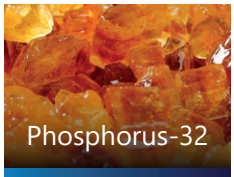
Representative examples

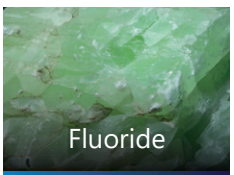


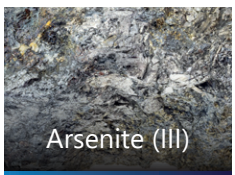


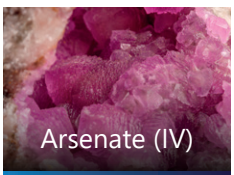












Capacity, Energy and Cost of Filtration

Adsorption capacities
Depends on each individual pollutants:
on average ≈0.5-1.0 g/m^2 of the absorbent

Cost of the filtration
Total cost of operation (Opex & Capex)
@ moderate pollution levels:
≈0.15-0.2 USD/m^3

Energy usage
0.075-0.1 kWh/m^3

CO_2: Compared to reverse osmosis, the BluAct technology saves 130 kg of CO_2 every 1.000 m^3 of purified water!

Representative arsenic data: approximate removal capacity at various arsenic contamination levels.

Representative arsenic data: approximate removal capacity and cost per m^3 of water treatment at various arsenic contamination levels.

Contamination Levels	Adsorption Capacity (m^3kg^{-1})	Cost CHF/m^3
Arsenic contamination 20 µg/L	**> 175 – 280**	**0.05 – 0.08**
Arsenic contamination 100 µg/L	**> 42 – 70**	**0.2 – 0.35**
Arsenic contamination 300 µg/L	**14 – 28**	**0.5 – 1.1**
Arsenic contamination 850 µg/L	**> 2.5**	**6**

Technical Specification

Practical size
12-40 US mesh
Maximum operating temperature
95° C
Optimum media contact time
6-10 min

Surface area
975m^2/g
Iodine number
1050
Specific density
0.67 kg/m^3

Regeneration / Backflushing
In certain applications, it is possible to regenerate onsite the granulated media after the saturation. Please follow the special instructions for this purpose. The media can be sterilized with hot water or chlorinated water.

Safety
No adverse effects are known when the product is used in accordance with its intended purpose and in accordance with the intended purpose. No safety data are required for the diaphragms. Storage, handling and transportation are not hazardous to humans or the environment.

Disposal
The media are to be treated as industrial waste after toxic metal adsorption during disposal. Please note, in consideration of the filtered product, the local and official regulations must be observed.

Storage
The media should be stored in original packaging in a dry and odorless place, protected against UV radiation. The media should be used within 36 months of the date of production.

Quality tested
During the manufacturing process, the media are continuously tested for consistently high product quality.

Applications

Our products are ideal to remove organic, inorganic, biological and micro pollutant contaminants from virtually any application sector, including industrial wastewater, Municipal water and radioactive wastewater treatment from hospitals and nuclear power industries.

Wastewater treatment
- Purification of industrial and municipal wastewater
- Groundwater remediation
- Preparation and treatment of process water
- Treatment of (landfill) leachate
- Radioactive pollutants removal

Drinking water
- Producing drinking water from ground water
- Water treatment for the food industry
- Reliable arsenic removal
- PFAS removal

Environment
- Phosphate removal from surface water
- Rehabilitation of eutrophicated waters
- Nutrient elimination in outdoor pools and garden ponds

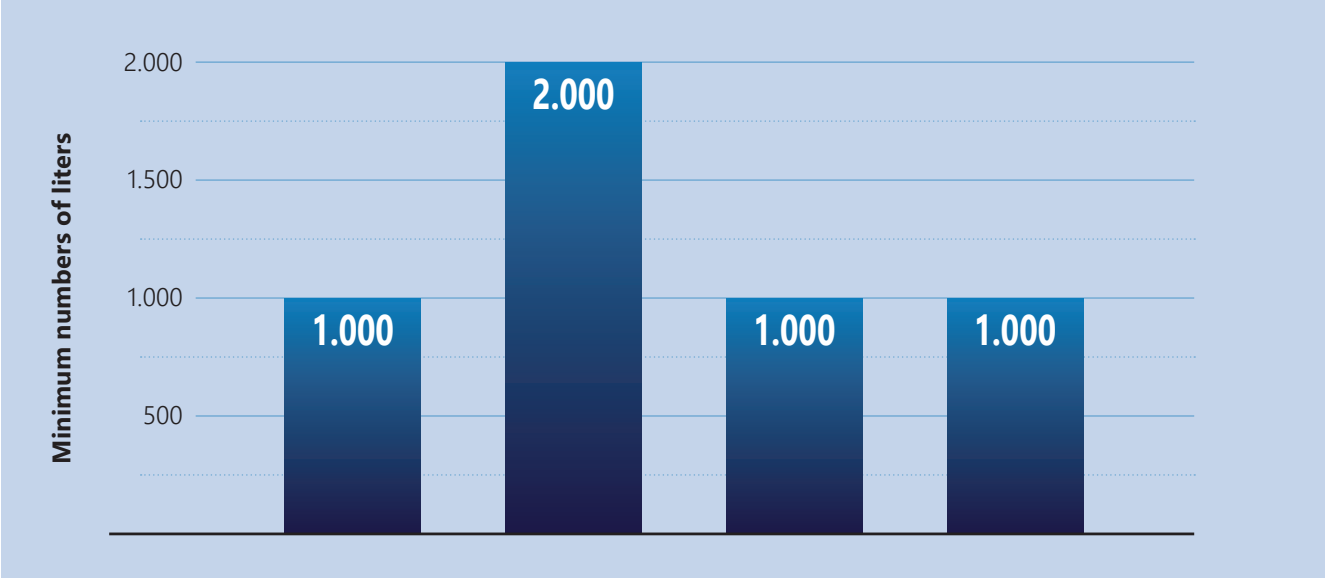
Certifications

BluAct products were tested and certified by several governmental and third-party laboratories, confirming the extraordinary performance of the products for multiple pollutant's removals, as well as meet and exceeding the regulatory requirements for the drinking water treatment.

The products obtained the following certifications:
- Heavy metals: Swiss, Indian and Peru (ongoing) governments.
- NSF53 requirements benchmarked and exceeded (see below)
- Food contact: full compliance with EU 1935/ 2004 regulations (independent tests from the TüV Rheinland in Italy and Labor Veritas in Switzerland).

NSF53 standards

Representative examples



The minimum number of liters treated by 0.3 kg BluAct granulated materials (GraPro) for various heavy metals removal according to NSF 53 standards.

References

1. Amyloid carbon Hybrid materials for universal water purification.
   Nature Nanotechnology, 2016, 11, 365–371
   http://dx.doi.org//10.1038/nnano.2015.310

2. Amyloid fibril-based membranes for PFAS removal from water.
   Environmental Science: Water Research & Technology, 2021, 7, 1873-1884
   https://doi.org/10.1039/D1EW00373A

3. Arsenic removal from Peruvian drinking water using milk protein nanofibril-carbon filters:
   a field study **Environmental Science: Water Research & Technology**, 2021,7, 2223-2230
   https://doi.org/10.1039/D1EW00456E

4. Sustainable Technologies for Water Purification from Heavy Metals:
   Review and Analysis **Chemical Society Reviews**, 2019, 48, 463-487.
   http://dx.doi.org//10.1039/C8CS00493E

5. An anti-viral trap made of protein nanofibrils and iron hydroxide Nanoparticles.
   Nature Nanotechnology, 2021, 16, 918-925.
   https://doi.org/10.1038/s41565-021-00920-5

6. Efficient purification of arsenic-contaminated water using amyloid-carbon hybrid membranes.
   Chemical Communications, 2017, 53, 5714-5717.
   http://dx.doi.org//10.1039/C7CC00406K

7. Selective and Efficient Removal of Fluoride from Water:
   In Situ Engineered Amyloid Fibril/ZrO2 Hybrid Membranes
   Angewandte Chemie, 2019, 58, 6012-6016.
   https://doi.org/10.1002/anie.201901596

8. Amyloid Fibrils Aerogel for Sustainable Removal of Organic Contaminants from
   Water **Advanced Materials**, 2020, 32, 1907932.
   https://doi.org/10.1002/adma.201907932

9. Amyloid hybrid membranes for bacterial & genetic material removal from
   water and their anti-biofouling properties. **Nanoscale Advances**, 2020, 2, 4665-4670.
   https://doi.org/10.1039/D0NA00189A

10. Amyloid hybrid membranes for removal of clinical and nuclear radioactive
    wastewater **Environmental Science: Water Research & Technology**, 2020, 6 , 3249-3254.
    https://doi.org/10.1039/D0EW00693A

11. Assessing the Binding Performance of Amyloid-Carbon Membranes toward
    Heavy Metal Ions **Langmuir**, 2019, 35 (11), 4161-4170.
    https://doi.org/10.1021/acs.langmuir.8b04234

12. Ubiquitous aluminium contamination in water and amyloid hybrid membranes as a sustainable
    possible solution **Chemical Communications**, 2019, 55 (74), 11143-11146.
    https://doi.org/10.1021/acs.langmuir.8b04234