ABSTRACT

Vitaqua is an advanced water purification catalyst engineered from high-performance natural zeolite. Through precise nano-structuring and ion-exchange optimization, Vitaqua effectively adsorbs a broad spectrum of industrial water contaminants, including ammonia (nitrogen compounds), peroxides, PFAS (per- and polyfluoroalkyl substances), heavy metals, and organic pollutants.

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Vitaqua – Advanced Zeolite-Based Catalyst for Industrial Water Treatment

Product Overview

Vitaqua is an advanced water purification catalyst engineered from high-performance **natural zeolite**. Through precise **nano-structuring and ion-exchange optimization**, Vitaqua effectively adsorbs a broad spectrum of industrial water contaminants, including **ammonia (nitrogen compounds)**, **peroxides**, **PFAS (per- and polyfluoroalkyl substances)**, **heavy metals**, and **organic pollutants**.

Its mechanism of action is both **physical and chemical**, utilizing **Van der Waals forces** and **ion exchange** to capture and neutralize toxic substances. During this process, it gradually releases beneficial trace minerals (e.g., **calcium, potassium, magnesium**) which contribute to water stabilization post-treatment.

Vitaqua Removal Capabilities

Contaminant	Removal Mechanism	Vitaqua Effectiveness
Lead (Pb^{2+})	Ion exchange with Ca^{2+}, Na^{+} in zeolite	✅ High – >90% removal
Iron (Fe^{2+}/Fe^{3+})	Adsorption + ion exchange	✅ High – Effective in groundwater applications
Chlorine (Cl_2)	Surface reaction + partial adsorption	⚠️ Moderate – not primary target but reduced
Ammonia (NH_3/NH_4^{+})	Strong ion exchange with zeolite cations	✅ Very high – up to 95%
Trihalomethanes (THMs)	Molecular adsorption (VOC-like compounds)	✅ High – similar to VOC adsorption
Peroxides (e.g., H_2O_2)	Reactive adsorption and decomposition	✅ Good – reacts with mineral surfaces
PFAS (long- & short-chain)	Nano-scale adsorption and sieving	✅ Excellent – engineered for PFAS selectivity

How It Works

- **Ion exchange: Swaps harmful metal ions (like Pb^{2+}, Fe^{2+}, NH_4^+) with safe mineral ions like Na^+, K^+**
- **Nanoporous adsorption: Traps organic compounds like THMs and peroxides inside its fine crystalline structure**
- **No chemical byproducts: Contaminants are immobilized, not transformed into secondary pollutants**

✅ **While chlorine isn't fully neutralized like with activated carbon, it can be reduced, and Vitaqua can be combined with carbon in dual-stage systems for comprehensive treatment.**

Key Benefits for Industrial Use

- **PFAS and VOC Removal**: Equivalent performance to reverse osmosis membranes and ion exchange resins at a lower cost
- **Multi-Contaminant Adsorption**: Simultaneously targets multiple industrial pollutants, including bacteria and viruses
- **Scalable Integration**: Customizable for large-scale installations including tanks, filtration beds, or cartridge systems
- **Eco-Friendly & Safe**: Made from natural ores, non-toxic, with no chemical byproducts
- **Cost-Effective**: Long lifecycle (up to 36 months) and regenerable options available

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Performance Specifications

Parameter	Specification
Base Material	Natural nano-engineered zeolite
Specific Surface Area	Enhanced (5x standard natural zeolite)
Adsorption Efficiency	Up to 95% (depending on contaminant type)
Particle Size	0.1 – 0.8 mm (customizable)
Application Form	Bulk granules, cartridge inserts, powder
Regeneration	Optional (thermal or pressure-based)
Shelf Life	36 months (dry)

Key Features

Property	Description
Base Material	Specially treated natural zeolite
Mechanism	Nanoporous adsorption + ion exchange (van der Waals interaction)
Target Contaminants	Peroxides, Ammonia (NH_3), PFAS, bacteria, viruses
Mineral Enrichment	Releases sodium, potassium, magnesium, calcium
Adsorption Capacity	5x improvement over untreated raw natural zeolite
Specific Surface Area	Significantly increased (nano-engineered particle structure)
Performance Equivalent To	Reverse osmosis membranes, ion exchange resins (e.g., PFAS removal)
Cost Efficiency	Low-cost natural ore base with competitive performance
Customization	Tunable composition for varied application needs

Recommended Applications

1. **Industrial Wastewater Treatment Plants**
    - Ammonia and PFAS capture (both long and short)
    - Effluent polishing and pre-discharge purification
    - Compatible with existing tank or columnar systems
2. **Municipal Water Sanitation Systems**
    - Backup filtration for emergencies and resilience upgrades
    - Legionella, E. coli, and virus suppression
3. **Closed-Loop Cooling Systems**
    - Inhibition of scale, biofouling, and organic contamination
    - Mineral balancing and long-term water stabilization

Large-Scale Water Quality Control

- Applicable for office buildings, hotels, condominiums, industrial, water treatment plants
- Complies with hygiene regulations for water storage tanks
- Installed in water reservoirs with optional activation system
- Validity: 1-3 year depending on continuous use

Deployment Guidelines

- **Dosage**: Approx. 5–10 kg/m^3 of water (adjust based on concentration levels)
- **Configuration**: Use in fixed-bed reactors, tank modules, or inline filters
- **Maintenance**: Recommended inspection after 24 months

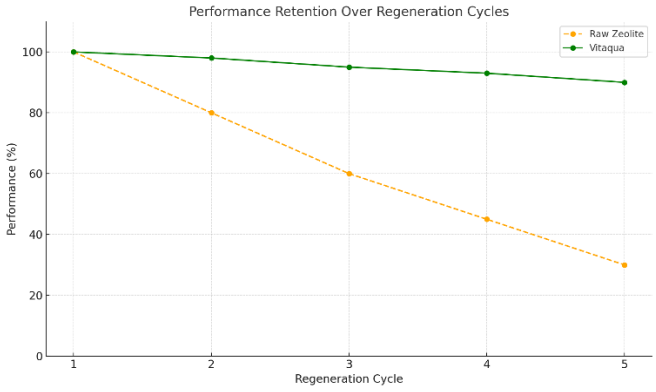

Figure 1samples available for small testing

Vitaqua vs. Raw Zeolite – Technical Comparison

Property	Raw Zeolite	Vitaqua Zeolite
Material Type	Untreated natural zeolite	Nano-engineered treated zeolite
Surface Area Enhancement	Standard (low)	5× increase
Contaminants Removed	Ammonia, some heavy metals	PFAS, VOCs, ammonia, bacteria, viruses
Adsorption Efficiency	Moderate (~40–60%)	High (up to 95%)
Regeneration	Limited (light rinse/heat)	Thermal or pressure regeneration
Usage Duration	Short (1–2 cycles)	Long (up to 36 months)
Water Stabilization	Partial	Yes (enhanced)
Form Factor Flexibility	Granules only	Granules, inserts, powder
Mineral Enrichment	Yes (moderate)	Yes (Na^+, K^+, Mg^{2+}, Ca^{2+})
Application Suitability	Aquaculture, basic filters	Industrial, municipal, closed-loop systems

Vitaqua vs Activated Carbon (GAC) – PFAS Removal Comparison

Feature	Activated Carbon (GAC)	Vitaqua
PFAS Removal (Long-chain)	Effective	Excellent
PFAS Removal (Short-chain)	Limited	Excellent
Regenerability	Rare (high-temp only)	Simple (heat/pressure flush)
Energy Requirement	High (for reactivation)	Low (ambient regeneration)
Cost Over Lifecycle	Moderate–High (frequent replacement)	Low (long-lasting, reusable)
Secondary Pollutants	Possible (when saturated)	None
Natural Composition	Synthetic Processed	Natural Zeolite
Effect on Water Taste	Can strip flavor	Improves taste
Mineral Enrichment	None	Na^+, K^+, Mg^{2+} enriched
Residual Disposal Impact	Waste disposal needed	Soil-safe, mineral return possible

Vitaqua vs Activated Carbon – Cost and Performance Comparison

Attribute	Activated Carbon (GAC)	Vitaqua
Initial Material Cost (per kg)	$2–5	$8 (treated)
Regenerability	Limited (requires high-temp)	✅ Yes (heat or pressure flush)
Number of Reuse Cycles	1–3	50–100
Regeneration Cost	High (thermal reactivation or replacement)	Low (ambient energy or flushing)
PFAS Removal (Long-chain)	✅ Effective	✅ Excellent
PFAS Removal (Short-chain)	⚠️ Limited	✅ Excellent
Heavy Metal Removal	✅ **Effective**	✅ **Excellent**
Chlorine Removal	✅ **Excellent**	⚠️ **Moderate**
Ammonia Removal	❌ Weak	✅ Very High
Operational Lifecycle Cost (per 1,000 L)	$0.05–$0.10	$0.0008
Waste Disposal Impact	⚠️ Requires incineration	♻️ Non-toxic, soil safe
Sustainability	⚠️ Fossil-derived, high energy use	✅ Natural mineral base, low energy
Safety (Drinking Water Contact)	✅ NSF certified	✅ NSF compliant (ceramic-grade zeolite)

Where Vitaqua Outperforms GAC

Category	Advantage
PFAS Removal (Short-chain)	GAC struggles, Vitaqua excels — this is a *huge* difference as short-chain PFAS are common and harder to remove.
Regenerability	Vitaqua can be flushed or lightly heated; GAC needs 800°C reactivation (usually not done).
Reuse Cycles	GAC = 1–3 cycles. Vitaqua = 50–100+ cycles. Massive difference in lifecycle cost.
Heavy Metals, Ammonia	Both can remove these, but Vitaqua has built-in ion exchange AND mineral release.
Operational Cost per 1,000 Litres	Vitaqua: ~$0.0008
Disposal	GAC must be incinerated; Vitaqua is soil-safe and natural.
Sustainability	GAC is fossil-derived and energy-intensive; Vitaqua is mineral-based and low-energy.

Conclusion

Vitaqua presents a scalable, low-cost, and highly efficient solution for industries seeking to meet increasingly strict water quality regulations, especially concerning emerging contaminants like PFAS both long and short. Whether as a primary solution or integrated enhancement to existing treatment infrastructure, Vitaqua bridges the gap between **natural mineral intelligence** and **modern engineering demands**.

Vitaqua Regeneration: How It Works

Vitaqua is made from **nano-engineered natural zeolite**, which unlike activated carbon or ion exchange resins, does not require aggressive chemical or high-energy regeneration.

Simple Regeneration Methods

Method	Description	Energy/Cost Impact
Low-Temperature Heating	Gently heat the saturated material (e.g. 80–120°C) to release adsorbed water and VOCs	Can be done with standard equipment
Pressure Flushing	Pass clean air or water under pressure through the material to flush out light contaminants	Useful for routine maintenance
Sun-Drying (for off-grid use)	In field settings, exposure to sun and airflow can partially regenerate the material	Ideal for low-tech, rural uses

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Why This Matters

- **No harsh chemicals** like brine (used in ion exchange)
- **No high-temp kilns** like with activated carbon reactivation
- **No toxic byproducts** — safe to handle and reuse
- Supports **decentralized or off-grid** installations where infrastructure is limited

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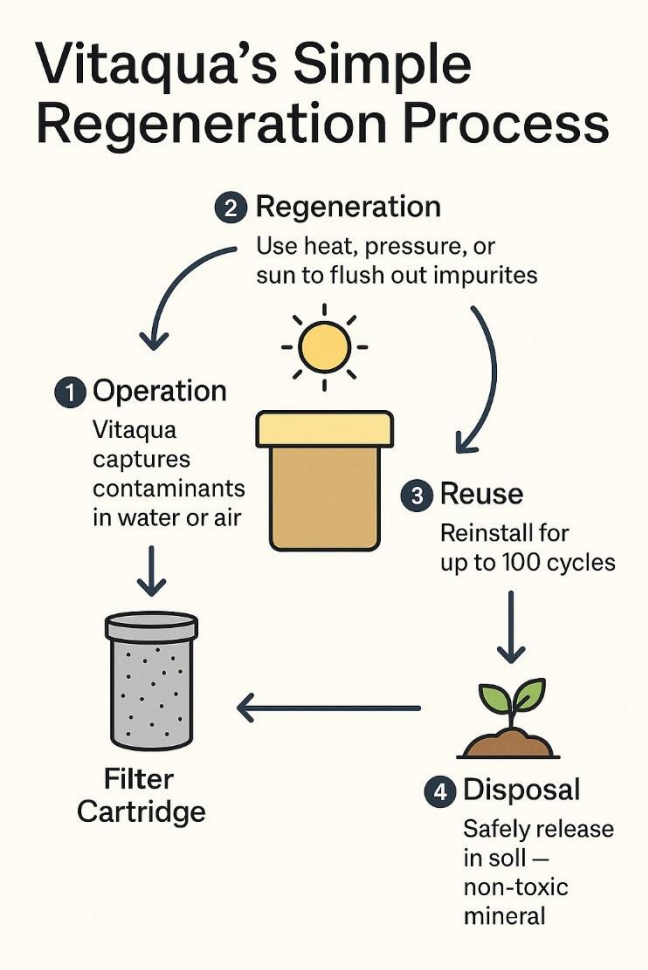
Typical Use Cycle

1. Install Vitaqua in cartridge or tank
2. Operate for 6–12 months depending on contaminant load
3. Remove and **flush or heat-dry** as needed
4. Reuse up to **100 cycles** (lab tested)
5. Dispose safely — can return to soil (non-toxic mineral)



Vitaqua regeneration "can be done with standard equipment", I mean it doesn't require specialized or industrial-scale tools — making it accessible for **small operators, rural facilities, or decentralized systems**.

What Counts as "Standard Equipment"?

Regeneration Method	Equipment Needed	Notes
Low-Temperature Heating	◆ Electric oven ◆ Heat box ◆ Drying chamber	Temps of ~80–120°C are sufficient to desorb moisture and organics (well below carbon reactivation temps of ~800°C)
Pressure Flushing	◆ Water pump ◆ Compressed air tank ◆ Filter backwash system	Used in cartridge or tank systems to flush out lighter contaminants like VOCs or sediments
Sun-Drying (Passive)	◆ Dry rack ◆ Mesh tray ◆ Solar box dryer	Effective in off-grid or agricultural settings — removes water and some adsorbed gasses

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Real-World Examples

- A **small municipal treatment facility** could regenerate Vitaqua media in a **basic drying oven**.
- A **greenhouse farm** using Vitaqua for water conditioning could air-dry or pressure-rinse media between growing cycles.
- In **disaster relief or off-grid setups**, sun-drying can extend the media's lifespan with zero energy input.

Why This Matters

- **No need for kilns or incinerators**
- **No hazardous chemicals or regeneration brine**
- **Safe to handle and reuse by non-specialists**
- **Low operating cost**, especially over 50–100 reuse cycles