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a Water Company

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SYSTEMS

SULFA TRAPP

ADVANCED MACROPOROUS SELECTIVE HYDROPHILIC TECHNOLOGY

INTRODUCING

PRECISION ENGINEERED FOR SULFATE & SULFIDE CONTROL

SulfaTrapp® is **Watch Water's flagship macroporous, weakly basic anion (WBA) ion capture media**, synthesized with a crosslinked polyacrylic framework and specialized tertiary and quaternary amine functional groups. Designed in Mannheim, Germany, it addresses elevated sulfate levels, gypsum scaling in RO systems, dissolved H_2S odors, and heavy industrial acid wastewater.

Unlike traditional polystyrenic that suffer from severe organic fouling and slow intraparticle diffusion, the acrylic matrix of **SulfaTrapp®** delivers superior hydrophilicity and open macropores - ensuring ultrafast kinetics, high reversible capacity, and outstanding resistance to osmotic shock.

CAPACITY
≥ 1.8 eq/L
Free base form, minimum guaranteed capture capacity

SELECTIVITY
> 99.2% Sulfate
Ultra-high preference over chloride and bicarbonate

PH OPERATING BAND
0 – 12
Full-range chemical stability, acid to alkaline

CERTIFICATION
NSF/ANSI
Polyacrylate matrix, ISO 9001:2015 manufactured

Engineered High-Capacity Technology for Targeted Sulfate (SO_4^{2-}) Capture, Hydrogen Sulfide (H_2S) Control, and Scaling Mitigation in Industrial & Municipal Water Systems.

CORE ADVANTAGES

Ultra-High Sulfate Preference
ideal amine charge spacing for divalent SO_4^{2-} over Cl^- and HCO_3^-

Zero Organic Fouling
open polyacrylic matrix prevents irreversible NOM/humic binding

Low Regenerant Consumption
only 110–120% stoichiometry with standard NaOH or Na_2CO_3

Dual Functionality
traps mineral acids while catalytically scavenging dissolved sulfides

IAPMO R&T WATER QUALITY PLATINUM SEAL
IAPMO RESEARCH AND TESTING

PREMIUM QUALITY
MADE IN GERMANY

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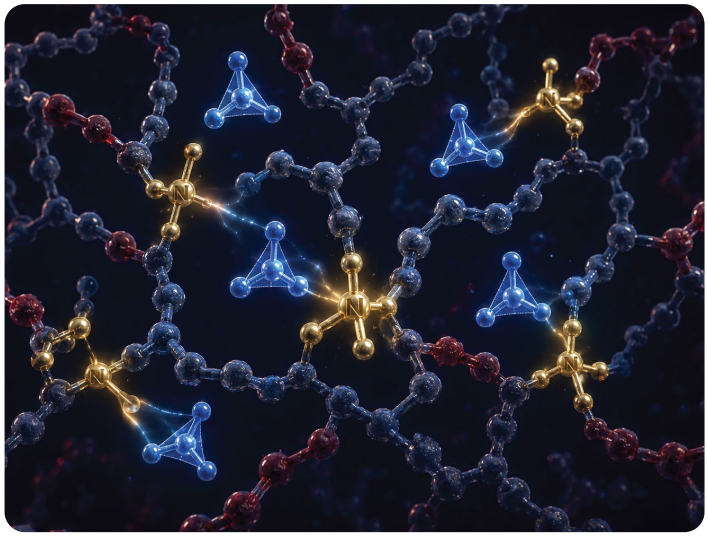
TECHNOLOGY FUNDAMENTALS

THE SULFATE & SULFIDE CHALLENGE IN MODERN WATER SYSTEMS

Sulfate (SO_4^{2-}) is one of the most ubiquitous anions present in natural groundwater, mining discharge, and industrial process streams. Elevated sulfate levels present multi-faceted operational and environmental hazards:



Severe RO Membrane Scaling

In Reverse Osmosis and Nanofiltration plants, concentrated sulfate combines with calcium and barium to form insoluble scale ($CaSO_4 \cdot 2H_2O$, $BaSO_4$). Gypsum scale is extremely difficult to remove chemically, leading to irreversible membrane compaction and premature replacement.

Biogenic Sulfide Generation (H_2S Corrosion)

Under anaerobic conditions in distribution pipelines, Sulfate-Reducing Bacteria (SRB) metabolize sulfate into highly corrosive, toxic, and odorous hydrogen sulfide gas H_2S, causing concrete micro-cracking and infrastructure destruction.

Regulatory Compliance

Drinking water guidelines (WHO, EU Directive 2020/2184, US EPA Secondary Standard) enforce a strict maximum concentration limit of 250 mg/L for sulfate to prevent gastrointestinal discomfort and laxative effects.

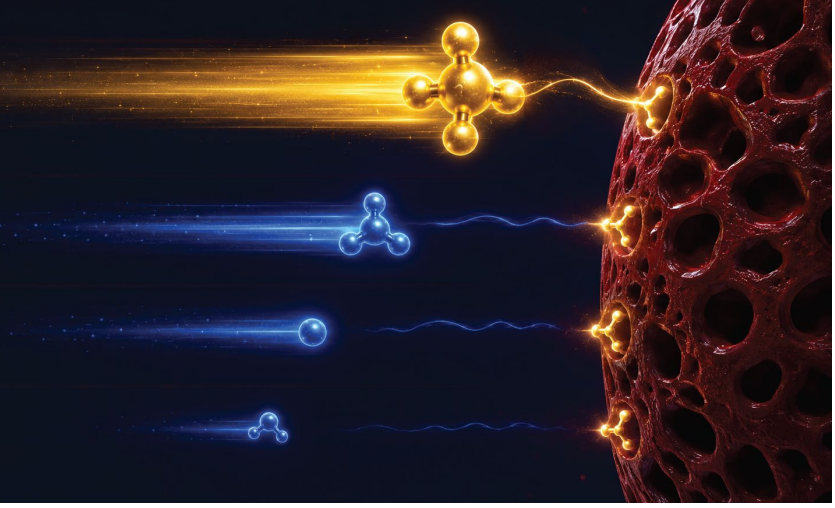
POLYMER ARCHITECTURE: ACRYLIC VS. STYRENIC

The physical matrix of an ion capture fundamentally governs its mass transfer velocity and fouling characteristics. Traditional styrenic possess hydrophobic aromatic rings that attract organic foulants via strong hydrophobic interactions (van der Waals forces).

Performance Property	SulfaTrapp® (Polyacrylic Matrix)	Standard Styrenic Anion
Matrix Structure	Aliphatic Crosslinked Polyacrylate	Divinylbenzene-Crosslinked Polystyrene
Hydrophilicity	Very High (Naturally Polar Matrix)	Low (Hydrophobic Aromatic Rings)
Fouling Reversibility	100% Organic Desorption on Alkali Clean	Irreversible Organic Poisoning / Capacity Loss
Hydraulic Kinetics	Rapid Intraparticle Diffusion (≤ 6 min EBCT)	Slower Kinetics (≥ 12 min EBCT required)
Osmotic Shock Resistance	Flexible Matrix (Expands/Contracts cleanly)	Rigid / Prone to Bead Cracking & Fines
Sulfate Affinity Factor	High Divalent Selectivity (α > 4.5)	Moderate Divalent Selectivity (α ≈ 2.0)

MACROPOROUS PORE DISTRIBUTION

SulfaTrapp® features a carefully engineered macroreticular pore network with an average pore diameter of 35–50 nm and an internal surface area of 55–65 m²/g. This enables the unhindered transport of bulky hydrated sulfate ions (r_h = 0.379 nm) directly to the active amine capture sites within the interior gel structure.



REACTION CHEMISTRY

ION CAPTURE & PROTONATION PATHWAYS

SulfaTrapp® functions predominantly through acid neutralization and anion-capture mechanisms. In its free-base (FB) form, containing tertiary amine groups ($R–N(CH_3)_2$), it reversibly adsorbs strong mineral acids (H_2SO_4, HCl, and HNO_3) from feedwater without producing salt by-products:

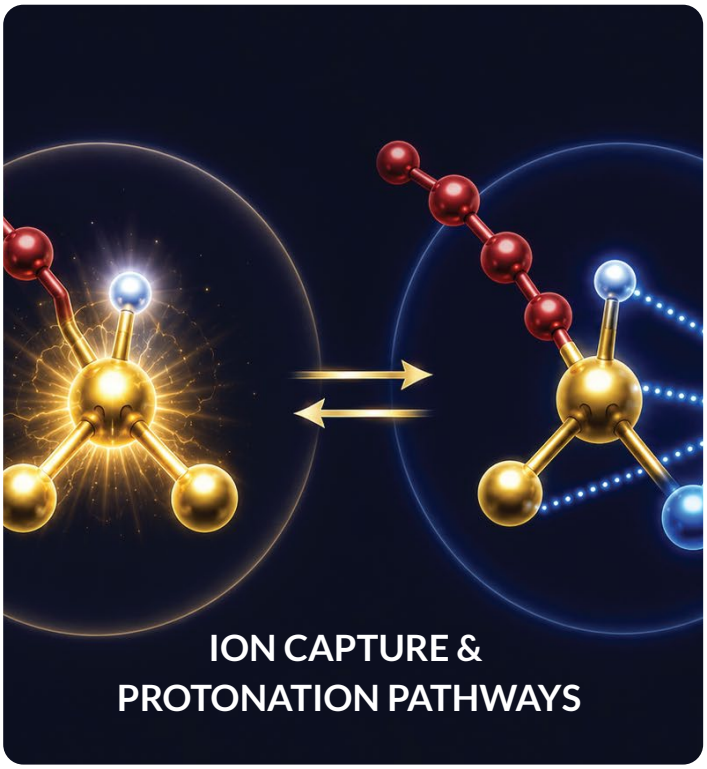
Free Base Acid Adsorption Reaction:

$$2R–N(CH_3)_2 + 2H^+ + SO_4^{2-} \rightleftharpoons [(R–NH^+(CH_3)_2)_2 \cdot SO_4^{2-}]$$

When operating in salt form (e.g., pre-protonated or chloride form), capture occurs via classic stoichiometric ion replacement:

Sulfate Capture with Chloride Release

$$2[R–NH^+(CH_3)_2 \cdot Cl^-] + SO_4^{2-} \rightleftharpoons [(R–NH^+(CH_3)_2)_2 \cdot SO_4^{2-}] + 2Cl^-$$



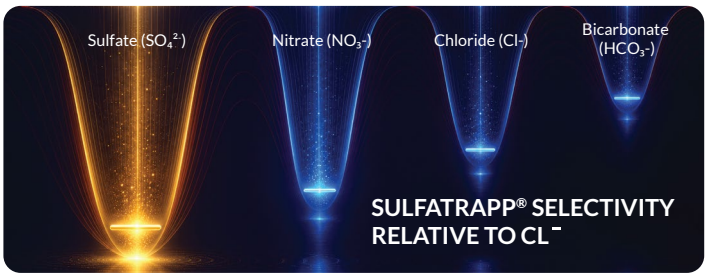
SELECTIVITY HIERARCHY & THERMODYNAMICS

The selectivity coefficient (K^A_β) defines the relative preference for anion A over anion B. For **SulfaTrapp®**, the ionic preference sequence at neutral to slightly acidic pH is:

$$SO_4^{2-} > HSO_4^- > NO_3^- > Cl^- > HCO_3^- > F^- > OH^-$$

The high selectivity for divalent sulfate over monovalent chloride is driven by electrostatic valence interactions and the standard free energy of hydration:

Anion	Ionic Charge	Hydrated Radius (Å)	Gibbs Hydration Energy (kJ/mol)	SulfaTrapp® Selectivity Relative to Cl^-
Sulfate (SO_4^{2-})	-2	3.79	-1080	4.85(Highest Affinity)
Nitrate (NO_3^-)	-1	3.35	-300	3.20
Chloride (Cl^-)	-1	3.32	-340	1.00 (Baseline)
Bicarbonate (HCO_3^-)	-1	4.00	-335	0.35



DISSOLVED SULFIDE SCAVENGING KINETICS

Beyond sulfate capture, **SulfaTrapp®** active sites catalytically bind aqueous hydrogen sulfide species (HS^-/H_2S) through hydrogen-bonding coordination and weak complexation - enabling simultaneous removal of taste/odor-causing sulfides alongside heavy sulfate loads in a single polishing stage.

Thermodynamic Driver

Divalent Charge + High Hydration Energy = Superior Sulfate Affinity

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TECHNICAL DATA SHEET

PROPERTY	SPECIFICATION
Polymer Matrix	Macroporous Crosslinked Polyacrylic
Functional Groups	Tertiary / Quaternary Amine
Ionic Form	Free Base (FB) / Hydroxide
Total Capture Capacity	≥ 1.8 eq/L (min.)
Moisture Retention	55% – 65%
Bead Size Range	0.315 – 1.25 mm
Uniformity Coefficient	≤ 1.55
Bulk Density	680 – 740 g/L
Particle Specific Gravity	1.08 – 1.12 g/cm^3
Chemical Stability	pH 0–14; resistant to mild oxidants

OPERATING CONDITIONS

PROPERTY	RECOMMENDED VALUE
Max. Operating Temp.	60°C (FB) / 80°C (Salt)
Operating pH Range	0.0 – 9.0 (Service)
Minimum Bed Depth	800 mm (1000–1500 mm rec.)
Service Velocity	8 – 35 BV/h
Linear Velocity	10 – 40 m/h
Backwash Expansion	50% – 75%
Regenerant	NaOH (preferred), Na_2CO_3, NH_4OH
Regenerant Conc.	2% – 4% NaOH
Regenerant Dosage	40 – 60 g NaOH / L

SIZING METHODOLOGY

STANDARDIZED SIZING ALGORITHM

Engineers size a **SulfaTrapp®** system by calculating the daily divalent ionic load, applying a net operating capacity correction, and determining required volume and vessel geometry.

1. Daily Divalent Ionic Load ($L_{daily} = Q \times CSO^4$)

$$L_{daily}(eq/day) = Q(m^3/day) \times \frac{\text{Sulfate concentration (mg/L)}}{48.03\ g/eq}$$

2. Net Operating Capacity ($TC \times \eta_{reg} \times f_{pH} \times f_{TDS}$)

$$OC_{net}\ (eq/L) = TC \times \eta_{re}g \times f_pH \times f_tDS$$

Required Volume (V_R)

$$VR(m^3) = \frac{L_{daily}(eq/day) \times {}^t cycle(days)}{OC_{net}(eq/L) \times 1000(L/m^3)}$$

Vessel Area & Bed Height

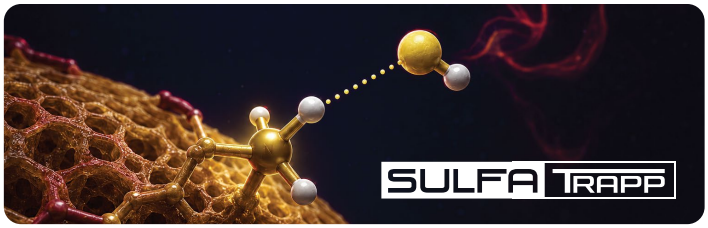
$$A_{vessel}(m^2) = \frac{Q_{peak}\ (m^3/h)}{V_{service}\ (m/h)}$$

$$\text{Bed Height(H)} \frac{VR}{Avessel} \geq 0.8m$$

Worked Engineering Example

Design Scenario: Industrial Reverse Osmosis Concentrate Post-Treatment Plant

Feed Flow Rate (Q)	120 m^3/h (2,880 m^3/day)
Feed Sulfate (SO_4^{2-})	480 mg/L (10.0 meq/L or 10.0 eq/m^3)
Target Run Length	12 hours between regenerations (0.5 days)
Selected Service Velocity	20 m/h



STEP-BY-STEP CALCULATION:

1. Calculate Ionic Load per Cycle

Volume per Cycle=120 $m^3/h \times 12h = 1{,}440\ m^3$
Total Ionic Load=1,440 $m^3 \times 10.0\ eq/m^3 = 14{,}400\ eq$

2. Determine the Net Operating Capacity (OC_{net})

Using a conservative regeneration stoichiometry of 115% NaOH:

$OC_{net} = 1.25 eq/L$

3. Calculate the Required Media Volume (V_r)

$$V_R = \frac{14{,}400\ eq}{1.25\ eq/L} = 11{,}520\ L = 11.52\ m^3$$

4. Vessel Sizing and Geometry

Required vessel area:

$$A_{vessel} = \frac{120\ m^3/h}{20\ m/h} = 6.00\ m^2$$

Internal vessel diameter:

$$D = \sqrt{\frac{4 \times 6.00}{\pi}} = 2.76m$$

Actual vessel area:

$$A = \frac{\pi \times (2.80m)^2}{4} = 6.16\ m^2$$

Actual bed height:

$$H = \sqrt{\frac{11.52\ m^3}{6.16\ m^2}} = 1.87m$$

Complies with the 0.8–2.0m design criterion.

5. Calculate the Regenerant Chemical Mass (100% NaOH)

$$\text{Pure NaOH} = \frac{11{,}520L \times 1.25eq/L \times 40g/eq \times 1.15}{1000\ g/kg} = 662.4\ kg$$

OPERATIONAL PERFORMANCE CURVES

Pressure Drop (ΔP) Characteristics

Service Velocity (m/h)	Service Velocity (gpm/ft²)	ΔP at 10 °C (bar/m)	ΔP at 20 °C (bar/m)	ΔP at 30 °C (bar/m)
10	4.1	0.08	0.06	0.04
20	8.2	0.18	0.13	0.10
30	12.3	0.29	0.22	0.17
40	16.4	0.42	0.32	0.25

Empirical Pressure Loss Equation

To calculate the exact pressure drop across a bed with a depth of H (m) at a temperature of T (°C):

$$\Delta P\ (bar) = 0.0058 \times v(m/h) \times H(m) \times \left(\frac{50}{T + 30}\right)$$

Backwash Expansion & Hydraulic Fluidization

Backwash Rate (m/h)	Bed Expansion % (10°C)	Bed Expansion % (20°C)	Bed Expansion % (30°C)
6.0	25%	18%	12%
8.0	42%	32%	22%
10.0	60%	48%	35%
12.0	80%	65%	50%
14.0	102%	82%	64%

Dynamic Breakthrough Curve Profiles

In service, **SulfaTrapp®** displays sharp breakthrough fronts for sulfate. Due to its superior divalent selectivity, chloride and nitrate breakthrough first, followed by a sudden sharp sulfate exhaustion edge:

Breakthrough Dynamics Summary:

0–70% of Run Duration: Sulfate leakage < 1.0 mg/L (99.8% removal).
75–90% of Run Duration: Slight chloride displacement wave (no impact on sulfate purity).
95–100% of Run Duration: Sharp, vertical sulfate breakthrough signal (> 25 mg/L endpoint cut-off)

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APPLICATION ENGINEERING & INTEGRATION

RO BRINE MINIMIZATION
GYPSUM SCALE ELIMINATION

High-recovery RO plants are severely constrained by calcium sulfate scaling in the tail-end membrane elements. Integrating **SulfaTrapp®** as a selective sulfate pretreatment or brine-recovery polishing loop reduces sulfate concentrations in the concentrate by **more than 95%**, enabling RO system recovery to increase from the standard **75% to 92–95%** without the risk of sulfate scaling.

PROCESS INTEGRATION DIAGRAM: RO CONCENTRATE RECOVERY

RO Primary Brine → SulfaTrapp® Column (Sulfate Removal) → **Secondary RO Unit** (High Recovery) → **Minimized Final Brine Volume**

MUNICIPAL & INDUSTRIAL
GROUNDWATER SULFATE REMEDIATION

In regions affected by mining activities or agricultural runoff, drinking water aquifers often exceed the 250 mg/L sulfate health guideline. **SulfaTrapp®** offers a simple single-column or lead-lag duplex arrangement that selectively targets sulfate without stripping essential minerals like calcium or magnesium, preserving natural water taste and balance.

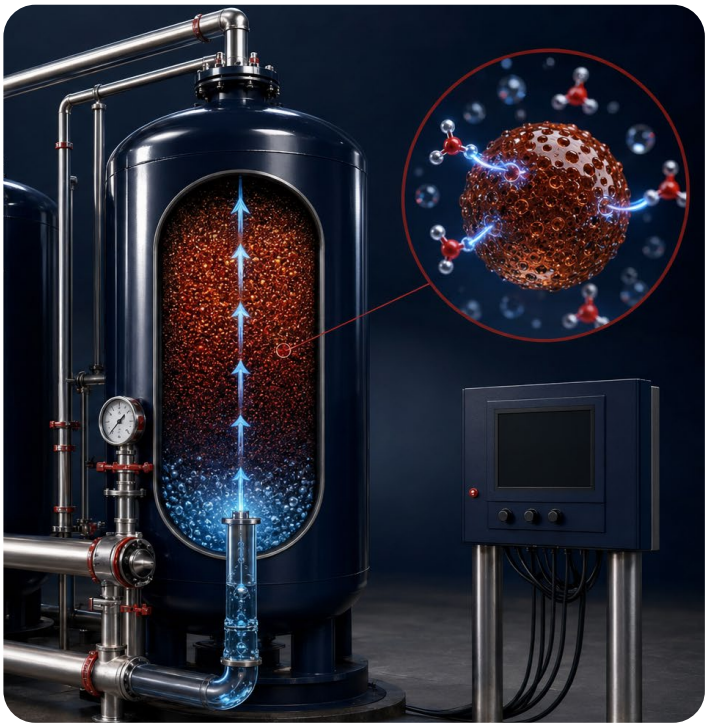
MINING & ACID MINE DRAINAGE (AMD) EFFLUENTS

Mining process waters contain high concentrations of free sulfuric acid (H_2SO_4) and dissolved heavy metals. Operating in its free-base form, **SulfaTrapp®** neutralizes acid loads while adsorbing large quantities of sulfate:

Influent AMD Parameter	Untreated Raw AMD	Post-SulfaTrapp® Effluent	Overall Reduction %
pH	2.4	6.8 – 7.2	Neutralized
Sulfate (SO_4^{2-})	1,850 mg/L	< 45 mg/L	97.6% Removal
Total Heavy Metals (Fe, Cu, Zn):	120 mg/L	< 0.5 mg/L (Precipitated)	> 99.5% Removal
Turbidity (NTU)	45 NTU	< 0.8 NTU	98.2% Removal

HYDROGEN SULFIDE (H_2S)
ODOR CONTROL IN WASTEWATER

When installed in municipal lift-station discharge lines or anaerobic wastewater-polishing systems, **SulfaTrapp®** removes up to **50 mg/L of dissolved H_2S**, eliminating toxic gas release, concrete sewer corrosion, and offensive rotten-egg odours.



REGENERATION GUIDELINES

STEP-BY-STEP REGENERATION SEQUENCE

To ensure maximum working capacity and long life, adhere strictly to Watch Water's standard co-current or counter-current regeneration sequence:

STEP NUMBER	SPECIFICATION	RAW FEED WATER	FLOW RATE (BV/H)	DURATION (MIN)	VOLUME (BV)
Step 1	Backwash & Bed Fluidization	Raw / Soft Water	10 – 12	15-20	2.5 – 3.5
Step 2	Regenerant Injection	2–4% NaOH	3-5	30-45	1.5 – 2.5
Step 3	Slow Displacement Rinse	Soft / RO Water	3-5	20-30	1.5 – 2.0
Step 4	Fast Flushing Rinse	Raw Feed Water	15-20	20-30	5.0 – 8.0
Step 5	Return to Standby / Service	Feed Water	15-35	Continuous	-

WATCH WATER'S STANDARD CO-CURRENT OR COUNTER CURRENT REGENERATION SEQUENCE

SAFETY & HANDLING PRECAUTIONS

SulfaTrapp® in Free Base form is a mild alkaline solid. Avoid contact with eyes and prolonged contact with skin. Wear safety goggles and protective gloves during handling. Store away from strong oxidizers (HNO_3), concentrated chlorine). Review Safety Data Sheet (SDS) prior to industrial application

STORAGE SPECIFICATIONS

Storage Conditions: *Store in original unopened packaging in a cool, dry, covered area at temperatures between 0°C and 40°C. Protect from freezing and direct sunlight.*

Shelf Life: *24 months from manufacturing date under sealed conditions.*

Standard Packaging

Packaging	Bag	Drum	Bulk Bag	Big Bag
Net Weight	25 kg	50 kg	500 kg	1,000 kg

★ *Other packaging can be considered on request*

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