METAL TRAPP

HIGH-SELECTIVITY CHELATING ADSORPTION TECHNOLOGY FOR DISSOLVED METALS

INTRODUCING

A MACROPOROUS CHELATING MEDIA BUILT FOR ONE JOB

Selective MetalTrapp® is a macroporous chelating adsorption media designed for the selective capture of dissolved polyvalent metals. Its functional chemistry forms strong coordination complexes with target metal cations while showing substantially lower affinity for monovalent background salts.

What makes the media selective

The media's selectivity is driven by its chelating iminodiacetic acid functionality, which provides multiple coordination sites for capturing dissolved metal cations. Its macroporous polymer structure creates accessible internal surfaces and efficient diffusion pathways, while the uniform, small-bead morphology improves mass transfer and maximizes the utilization of active sites. High mechanical and osmotic stability also enables reliable performance through repeated service, regeneration, and conditioning cycles. The degree of selectivity depends on factors such as the metal species and oxidation state, water pH, competing ions, complexing agents, metal concentration, and contact time.

Typical project objectives

The media is designed for heavy-metal polishing of industrial water and wastewater, including the removal of trace metals before discharge, reuse, or high-purity processing stages. It can selectively capture alkaline-earth contaminants from concentrated salt streams and support metal recovery and concentration where reusable capture and regeneration cycles offer operational advantages. The media can also serve as a protective guard bed for downstream membranes, catalysts, electrochemical processes, and other sensitive process equipment.

Important

The media is selective, but no universal operating capacity should be applied to every water. Working capacity must be established from feed composition, pH, competing ions and the required treated-water limit. Pilot testing or representative laboratory loading tests are strongly recommended for critical projects.

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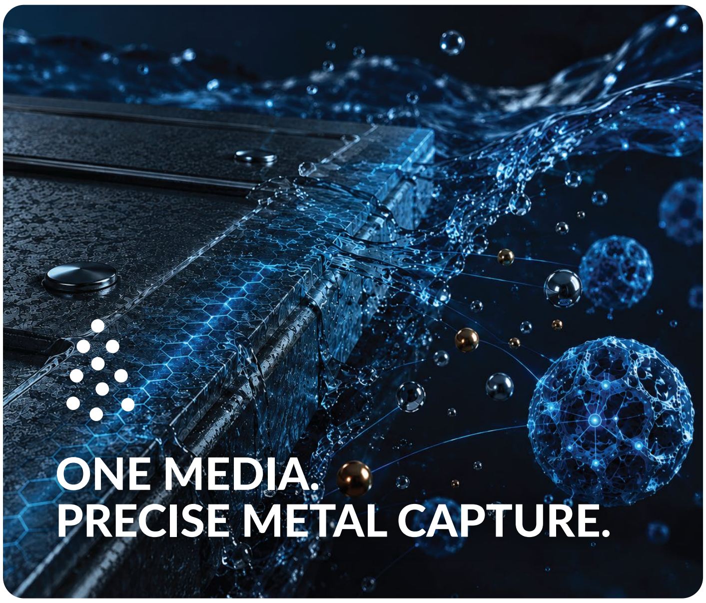
HOW SELECTIVE METALTRAPP® WORKS

FROM FEED TO BREAKTHROUGH: THE SERVICE CYCLE

The active sites coordinate dissolved metal cations. During service, target metals migrate from the liquid phase into the porous bead and bind to the chelating sites. When the planned working capacity or breakthrough criterion is reached, the bed is regenerated with acid, rinsed, then chemically conditioned to restore the required service form.



Simplified service cycle

1. Feed enters a packed **Selective MetalTrapp®** bed at controlled velocity.
2. Target metal cations diffuse into the macroporous bead.
3. Chelating sites preferentially coordinate target metals according to the prevailing chemistry.
4. The mass-transfer zone moves through the bed as loading increases
5. Breakthrough is detected at the lead-vessel outlet.
6. The lead bed is removed from service for regeneration; the lag bed becomes the new lead bed.

Factors that control performance

Factor	Engineering significance
pH	Strongly influences metal speciation, site availability and working capacity.
Competing Ca/Mg	Can consume capacity where concentrations are high; must be included in design loading.
Metal oxidation state	Changes affinity and speciation; analysis should identify the actual dissolved form.
Complexing agents	Strong chelants can keep metals unavailable to the media.
Suspended solids	Cause fouling and hydraulic plugging; prefiltration is essential for small-bead media.
Flow / BV/h	Higher flow shortens contact time and can reduce polishing depth.
Temperature	Affects kinetics and viscosity; remain within specified operating range.
Bed depth	Adequate depth is necessary to contain the mass-transfer zone and achieve low leakage.

METAL SELECTIVITY & CHEMICAL COMPATIBILITY

SELECTIVITY IS A SEQUENCE, NOT A GUARANTEE

A useful reference order for divalent and polyvalent metal capture is shown below. It is indicative, not absolute; actual separation depends on pH, speciation, background electrolyte and complexing chemistry.

Cu ▸ V species ▸ UO_2^{2+} ▸ Pb ▸ Ni ▸ Zn ▸ Cd ▸
Fe^{2+} ▸ Be ▸ Mn ▸ Ca ▸ Mg ▸ Sr ▸ Ba ▸ Na

Strongly complexed metals

If a dissolved metal is already bound by a stronger soluble complexing agent, capture can be severely reduced. Waters containing strong aminopolycarboxylate chelants require special evaluation. Metal-cyanide complexes also require dedicated testing; they should not be assumed to behave like free metal cations.

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Water chemistry information required before design

- pH, temperature and conductivity/TDS
- Total and dissolved concentration of every target metal
- Calcium, magnesium, strontium and barium
- Iron and manganese, including oxidation state where relevant
- Sodium, chloride, sulfate, carbonate/bicarbonate and major salts
- Organic carbon, oil/grease and surfactants
- Suspended solids and turbidity
- Presence of complexing/chelating chemicals
- Required treated-water concentration and analytical detection limit

RECOMMENDED SYSTEM ARCHITECTURE

LEAD/LAG: TURNING BREAKTHROUGH INTO A CONTROLLED EVENT

Feed Water : Inlet sampling + isolation

Prefiltration Protect the selectivebed

Vessel A : Lead adsorption stage

Vessel B Lag / polishing stage

Final Sampling : Quality verification

Normal duty: A ➞ B. At lead breakthrough: regenerate A, move B to lead, return regenerated A as lag.

Water chemistry information required before design

The system uses two equally sized vessels arranged in series, with Vessel A operating as the lead vessel and Vessel B serving as the lag or polishing vessel. Sample points installed after each vessel enable early detection of breakthrough in the lead bed. When Vessel A reaches the predetermined breakthrough limit, it is isolated and regenerated, while Vessel B is moved into the lead position. After regeneration, Vessel A returns to service as the lag vessel, restoring a fresh polishing barrier. This rotating lead–lag configuration maximizes the media's usable loading capacity while consistently protecting the required final-water quality.

Single-vessel operation

A single vessel can be used where treated-water limits are less critical, shutdown is acceptable during regeneration, or an upstream/downstream buffer is available. The design must still provide sufficient bed depth, freeboard, backwash capability and sampling.

Recommended instrumentation

Instrument / connection	Purpose
Inlet flow meter	Maintain design BV/h and document throughput.
Inlet and outlet pressure gauges	Track differential pressure and detect fouling.
Sample valves: feed / after lead / final	Trend breakthrough and confirm final quality.
pH and conductivity	Verify feed chemistry, regeneration and rinse endpoints.
Totalized flow	Calculate bed volumes treated and cycle productivity.
Chemical tanks / dosing pumps	Controlled acid regeneration and alkaline conditioning.
Drain / neutralization connection	Safe handling of displaced metals and regenerants.
Optional online metal analyzer	High-value or high-risk applications requiring rapid breakthrough response.

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HYDRAULIC & VESSEL DESIGN

PROPERTY	REFERENCE SPECIFICATION / DESIGN GUIDANCE
Service flow	5-25 bed volumes per hour (BV/h); lower range preferred for stringent polishing
Single-column bed depth	Minimum 1,000 mm.
Recommended design bed depth	Typically 1,000–1,200 mm for industrial polishing; verify pressure drop and mass-transfer requirements.
Backwash freeboard	Minimum 100% of settled media volume for full expansion capability.
Backwash expansion reference	Approx. 5% bed expansion per m/h at 20°C; actual expansion depends on water temperature and bead condition.
Maximum bed differential pressure	250 kPa across the media bed.
Specific pressure-loss reference	Approx. 1.1 kPa·h/m² at 15°C as a media reference value; actual vessel loss depends on velocity and internals.
Operating temperature	Up to 80°C within compatible vessel/valve/material limits.
Operating pH during service	2-12
Chemical stability pH	0-14

Vessel internal design

- Uniform inlet distributor to prevent channeling.
- Retention system selected for the small bead size; slot/opening must prevent media loss.
- Low dead-volume bottom collector with uniform hydraulic collection.
- Backwash distribution capable of lifting the entire bed evenly.
- Sight glass or calibrated vessel volume is useful for confirming expansion where practical.
- Nozzle and piping velocities should be controlled to limit hydraulic shock and bead movement.

APPLICATIONS

Industrial wastewater polishing

Final selective removal after precipitation, clarification and filtration

Metal finishing / plating

Polishing or recovery of dissolved Cu, Ni, Zn, Cd and related metals.

Mining / hydrometallurgical water

Selective polishing after bulk solids and dissolved-load reduction.

High-salt process streams

Removal of trace hardness or metals from concentrated saline streams.

Process-water reuse

Guard stage to prevent metal accumulation in recycled water loops.

Membrane pretreatment

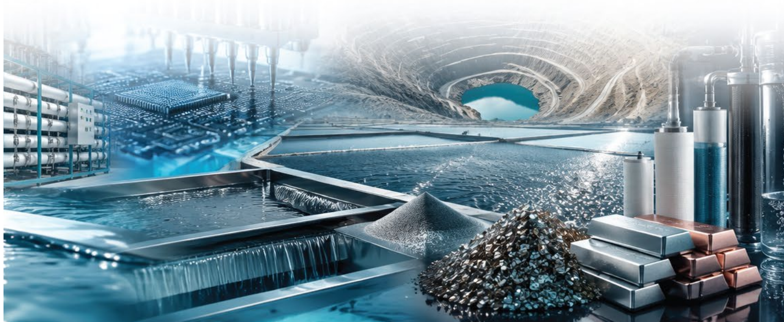
Trace-metal control to reduce scaling, fouling or catalytic damage downstream.

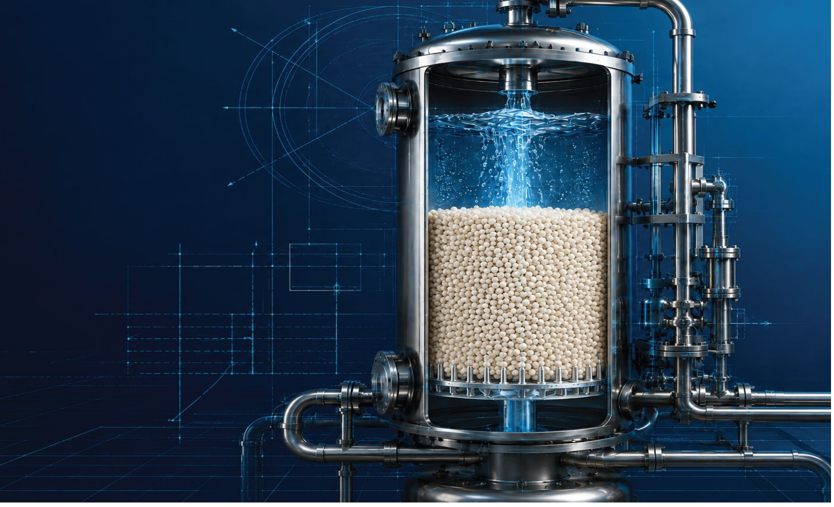
Electronic / specialty process water

Low-leakage polishing where trace cations affect process quality

Metal recovery systems

Capture, regeneration and concentration of valuable metal streams when chemistry permits





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SIZING & ENGINEERING CALCULATIONS

TWO CONSTRAINTS, ONE SIZING RULE

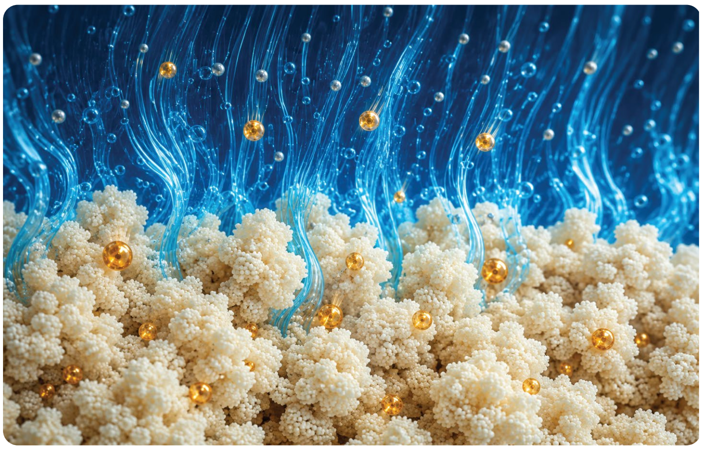
Key sizing rule

Media volume is governed by both hydraulic contact rate and metal-loading capacity. Calculate both, then use the larger media requirement.

Hydraulic sizing from BV/h

Media volume (L) = Flow (m³/h) × 1,000 ÷ Selected service rate (BV/h)

Flow	At 5 BV/h	At 10 BV/h	At 15 BV/h	At 20 BV/h	At 25 BV/h
0.5 m³/h	100 L	50 L	33 L	25 L	20 L
1 m³/h	200 L	100 L	67 L	50 L	40 L
2 m³/h	400 L	200 L	133 L	100 L	80 L
5 m³/h	1,000 L	500 L	333 L	250 L	200 L
10 m³/h	2,000 L	1,000 L	667 L	500 L	400 L



Bed geometry

Required bed cross-sectional area A (m²) = Media volume V (m³) ÷ selected settled bed depth H (m).

Equivalent internal vessel diameter D (m) = √(4A / π).

Example: 500 L media at 1.10 m bed depth -> A = 0.455 m² -> D ≈ 0.76 m. Select the next practical vessel size and verify actual bed depth/freeboard.

Metal-loading calculation

For each dissolved metal, convert concentration to equivalents. Equivalent weight EW = atomic/molecular weight ÷ ionic charge. For a concentration C in mg/L, the equivalent loading entering with 1 m³ of water is approximately C ÷ EW equivalents per m³.

Total equivalent loading (eq/m³) = Σ [C_i (mg/L) ÷ EW_i (g/eq)].

Projected cycle throughput (m³) = Usable working capacity (eq/L media) × Media volume (L) ÷ Total equivalent loading (eq/m³).

Design caution

Do not use total theoretical capacity as the working capacity. Apply a project-specific usable capacity established from pilot data, breakthrough curves, or a validated safety factor. Competing Ca/Mg and other metals must be included whenever they are captured under the operating chemistry.

CAPTURING TARGET METALS. LEAVING BACKGROUND SALTS BEHIND.

Example - engineering method only

Assume 200 L media and a project-validated usable capacity of 0.50 eq/L. Available working charge = 100 eq. If the summed feed-metal loading is 0.25 eq/m³, the calculated loading-limited throughput is 400 m³. Apply a design safety factor and the lead/lag breakthrough criterion before setting the operating cycle.

Empty-bed contact time

EBCT (minutes) = 60 ÷ BV/h. Examples: 5 BV/h = 12 min; 10 BV/h = 6 min; 20 BV/h = 3 min; 25 BV/h = 2.4 min.

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PRETREATMENT & FEED-WATER REQUIREMENTS

SMALL BEADS MEAN FAST KINETICS – AND LOW TOLERANCE FOR SOLIDS

Why pretreatment matters

Selective MetalTrapp® uses small beads for fast kinetics. This improves mass transfer but increases sensitivity to solids loading. Fine suspended material can occupy void space, increase differential pressure and shield active surfaces.

Recommended pretreatment train

- Equalization and pH control where feed chemistry varies.
- Bulk metal precipitation where economically justified, followed by clarification.
- Oil/grease and free-organic removal where present.
- Multimedia or equivalent solids filtration.
- Final cartridge/bag filtration sized to protect the bed; project-specific rating commonly selected in the fine-filtration range.
- Oxidation-state control where Fe/Mn or other species can precipitate inside the bed.

Feed conditions that require special review

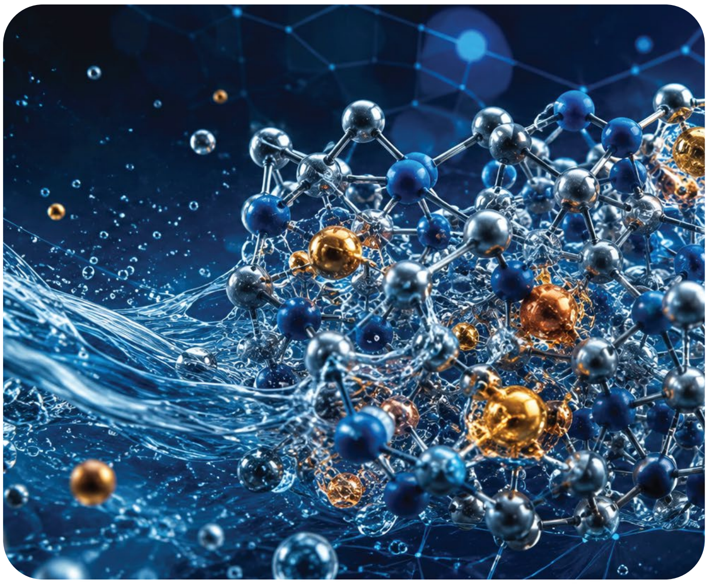
Condition	Risk / required action
High hardness	May consume capacity and shorten cycles.
High suspended solids	Bed fouling and pressure rise; improve filtration.
Strong soluble chelants	Can suppress capture; bench testing required.
Oil / surfactants	Surface fouling and wetting changes; remove upstream.
Precipitating chemistry	Deposits inside bed; stabilize pH/oxidation state before adsorption.
Rapid pH swings	Can change selectivity and loading; use equalization/control.
High temperature	Verify all vessel, gasket, valve and chemical-system ratings

OPERATING PROCEDURE

NORMAL SERVICE AND SHUTDOWN

Normal service

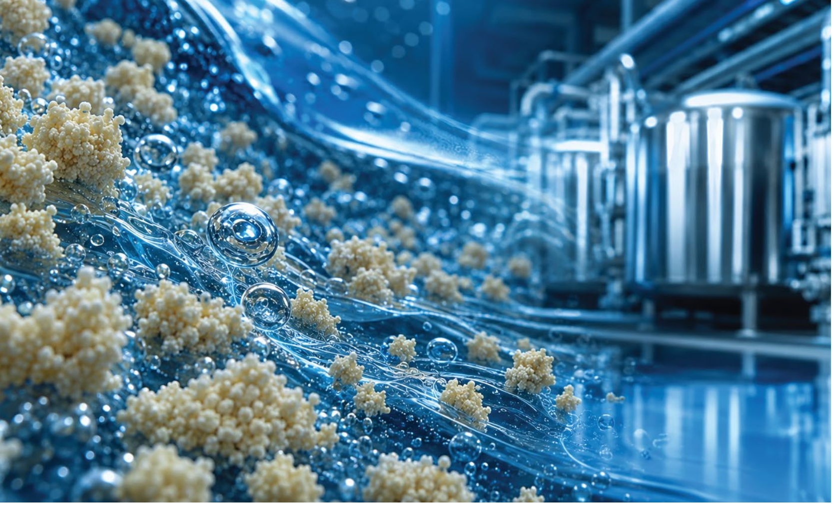
- Confirm vessel is fully flooded and air is displaced.
- Set service flow gradually; avoid hydraulic shock.
- Record initial clean-bed differential pressure.
- Verify feed pH and temperature are within the design window.
- Start totalized-flow and sampling records.
- Monitor after lead vessel and at final outlet according to the project sampling plan.
- Trend differential pressure, pH, conductivity and metal leakage against bed volumes treated.



Shutdown

For short shutdowns, keep the bed flooded with compatible water and isolated from contamination. For extended shutdowns, follow the project preservation procedure, taking account of microbial control, chemical compatibility and subsequent rinse requirements.

TARGETED METAL CAPTURE - EVEN IN COMPLEX WATER



BREAKTHROUGH MONITORING & LEAD/LAG ROTATION

TWO LIMITS, DEFINED BEFORE COMMISSIONING

Establishing the trigger

Define two limits before commissioning: (1) lead-vessel breakthrough trigger and (2) absolute final-water specification. The lead trigger should be significantly below the final limit so that the lag vessel remains a reliable polishing barrier.

Rotation logic

- Lead outlet begins to approach the predefined trigger.
- Confirm result with a second sample or validated online instrument.
- Remove the lead vessel from service and direct flow through the lag vessel as the new lead.
- Regenerate and condition the exhausted vessel.
- Return the regenerated vessel downstream as the new lag/polisher.
- Reset cycle totals and retain laboratory results for capacity trending.

PERFORMANCE TRENDING

Track metal mass captured per cycle, BV treated, regenerant consumption, rinse water and pressure drop. A declining trend can reveal fouling, feed chemistry changes, incomplete regeneration or media aging long before final-water quality is lost.

COMPLETE REGENERATION & CONDITIONING GUIDELINES

REGENERATION & CONDITIONING SEQUENCE

Backwash
Classify bed / remove solids

Acid Regeneration
4–10 wt.% HCl · ≥150 g/L media

Conditioning
~4 wt.% NaOH · 80–96 g/L media

Slow Rinse
≥4 BV at regeneration flow

Slow Rinse
≥4 BV at conditioning flow

Final Rinse
Rinse to project endpoint

Regenerant handling, neutralization, disposal and final rinse acceptance limits must follow site chemical-safety and wastewater requirements.

Chemical quantity calculations

Pure HCl (kg) = Media volume (L) × 0.150 kg/L or greater

Commercial HCl solution required (kg) = Pure HCl required ÷ mass fraction of supplied acid. Example: 100 L media ⟶ minimum 15 kg pure HCl. With 30 wt.% commercial acid: 15 ÷ 0.30 = 50 kg of solution before dilution to the selected regeneration concentration.

Pure NaOH (kg) = Media volume (L) × 0.080–0.096 kg/L

Example: 100 L media ⟶ 8.0–9.6 kg pure NaOH. For 50 wt.% caustic solution, required commercial solution = 16.0–19.2 kg before dilution to approximately 4 wt.%.

Reference chemical sequence

Stage	Reference condition	Purpose
Backwash	Expand and classify bed; determine site flow from vessel/media expansion test.	Remove trapped solids and release compaction.
Acid regeneration	HCl approximately 4-10 wt.%	Displace captured metal cations and restore acidic active-site form.
Acid dose	Minimum 150 g pure HCl per L of media	Reference minimum chemical quantity; optimize only with validated cycle data.
Acid contact	Minimum 20 min	Provide chemical contact through the full bed.
Slow rinse	Minimum 4 BV at regeneration flow	Displace spent acid/metal solution without remixing.
Alkaline conditioning	NaOH approximately 4 wt.%	Convert the media to the required sodium service form.
NaOH dose	80-96 g pure NaOH per L of media	Reference conditioning quantity.
Conditioning contact	Minimum 20 min	Allow complete conversion through the bed
Final rinse	Continue to project acceptance endpoint	Prepare bed for service; confirm pH/conductivity and chemical residual criteria.

Rinse-water calculations

One bed volume (BV) = one settled media volume. Therefore 100 L media ⟶ 4 BV slow rinse = minimum 400 L per referenced slow-rinse stage. Additional final rinse water is determined by the project endpoint.

Regeneration flow direction

Co-current regeneration is the baseline reference. Piping may be engineered for alternative regeneration strategies only after verifying bed hydraulics, chemical distribution, media retention and performance with representative testing.

Spent regenerant management

Spent acid regenerant contains concentrated captured metals and must be collected for controlled neutralization, metal recovery or approved disposal. Do not discharge regenerant without verifying local wastewater limits and the chemistry of the recovered metals. Acid and alkaline waste streams should be managed using site-specific chemical-safety procedures.

SAFETY CRITICAL

Always add acid to water - never water to concentrated acid. Acid and caustic preparation systems require suitable PPE, ventilation, compatible tanks/pumps/piping, spill containment, eyewash/-shower access and trained operators.

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DETAILED TECHNICAL DATA SHEET

Product identity & structure

Property	Selective MetalTrapp® specification
Product type	Selective chelating adsorption media
Delivery ionic form	Na^+
Functional chemistry	Iminodiacetic-acid chelating functionality
Polymer matrix	Styrenic
Structure	Macroporous
Appearance	Beige, opaque beads
Uniformity coefficient	≤1.1
Mean bead size d50	0.55 - 0.65 mm
Total capacity, H^+ reference form	Minimum 2.8 eq/L

Operating data

Parameter	Value
Maximum operating temperature	80°C
Operating pH during service	2-12
Minimum single-column bed depth	1,000 mm
Service flow rate	5-25 BV/h
Reference backwash expansion	Approx. 5% per m/h at 20°C
Minimum freeboard for backwash	100 vol.% of settled bed
Reference specific pressure loss	Approx. 1.1 kPa·h/m² at 15°C
Maximum pressure loss during operation	250 kPa

Typical physical & chemical properties

Property	Typical / specified value
Bulk density for shipment	Approx. 700 g/L (±5%)
Particle density	Approx. 1.16 g/mL
Water retention, delivery form	Approx. 59-65 wt.%
Volume change, $Na^+ \rightarrow H^+$	Maximum approx. -35%
Chemical stability pH range	0-14
Temperature stability range	1-80°C
Recommended storage temperature	-20 to +40°C; prevent repeated freeze/thaw and container damage

Regeneration & conditioning data

Parameter	Value
Acid regenerant	Hydrochloric acid
Acid concentration	Approx. 4-10 wt.%
Acid quantity, co-current	Minimum 150 g pure HCl/L media
Acid contact time	Minimum 20 min
Slow rinse after acid	Minimum 4 BV at regeneration flow
Conditioning chemical	Sodium hydroxide
Conditioning concentration	Approx. 4 wt.%
NaOH quantity	80-96 g pure NaOH/L media
Conditioning contact time	Minimum 20 min
Slow rinse after conditioning	Minimum 4 BV

DATA-SHEET NOTE

Values above are reference specifications for engineering. Final system design must consider actual feed composition, pressure vessel geometry, distributor design, temperature, required treated-water limit and site chemical-handling rules.

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COMMISSIONING PROTOCOL

MECHANICAL CHECKS, MEDIA LOADING & ACCEPTANCE TESTING

Mechanical checks

Before commissioning the system, verify the vessel pressure rating, chemical compatibility, and correct installation of all internal distributors. Confirm that the retention elements are suitable for the specified media bead size to prevent media loss during service and backwash. Pressure-test all piping and inspect isolation and bypass valves to ensure proper operation and leak-free performance. Before introducing any chemicals, confirm that the drain and neutralization system is fully prepared and operational. Finally, calibrate all flow, pressure, pH, and analytical instrumentation to ensure accurate monitoring, safe operation, and reliable system performance.

Media loading

- Add clean water to the vessel before adding media where required by the vessel loading procedure.
- Load the specified volume without damaging beads or internals.
- Allow media to wet and settle fully.
- Backwash gradually to classify the bed and remove fines/air.
- Confirm settled bed depth and available freeboard.

Chemical conditioning before first service

Where the supplied media form and the application require conditioning, execute the project-approved acid/conditioning sequence and rinse to acceptance. Do not place the bed into critical service until outlet pH, conductivity and any specified residual chemical endpoint are stable.

Performance acceptance test

Stage	Reference condition
Hydraulic	Stable design flow with differential pressure within calculated/commissioned baseline.
Leak test	No vessel, piping or chemical-system leakage.
Water quality	Final outlet meets the agreed target-metal specification.
Sampling agreement	Feed, lead outlet and final sample points produce reproducible results.
Cycle baseline	Record start date, media volume, BV/h, pH, temperature and feed-metal profile.

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TROUBLESHOOTING & PERFORMANCE OPTIMIZATION

Symptom	Likely causes	Corrective actions
Poor regeneration recovery	High competing load; pH shift; excessive flow; insufficient bed depth; strong soluble complexes	Recheck complete analysis; reduce BV/h; correct pH; verify loading model; perform pilot breakthrough test.
High differential pressure	Solids fouling; precipitation; bed compaction; distributor issue	Backwash; improve pretreatment; inspect chemistry and internals.
Poor regeneration recovery	Insufficient acid dose/contact; channeling; chemical dilution error; fouling	Verify concentration and dose; increase contact within specification; inspect distribution and pretreatment.
High metal leakage after regeneration	Incomplete conditioning/rinse; damaged bed; wrong service chemistry	Repeat conditioning/rinse; verify pH and chemistry; assess media integrity.
Media loss	Retention opening too large; hydraulic shock; excessive backwash	Inspect retainers and flow control; correct backwash ramp rate.
Cycle capacity declining	Fouling, irreversible contamination, feed change or incomplete regeneration	Trend mass balance; clean/restore if validated; update design or replace media when necessary.

SAFETY, HANDLING, STORAGE & DISPOSAL

Media handling

- Keep product in closed original packaging until use.
- Store dry and protected from direct heat and physical damage.
- Avoid unnecessary freezing/thawing cycles even where short-term storage temperatures may be below 0°C.
- Prevent contamination with oils, oxidants, incompatible chemicals or biological material.
- Use normal industrial hygiene and dust/splash precautions during loading and unloading.

Chemical handling

Hydrochloric acid and sodium hydroxide are corrosive. Chemical systems must use compatible materials and comply with site SDS instructions, PPE requirements, bunding/secondary containment, ventilation, emergency shower/eyewash and spill response procedures.

Disposal / recovery

Spent media and spent regenerant can contain hazardous or valuable metals. Characterize them before disposal. Where economically feasible, the concentrated regenerant may be routed to metal recovery. Disposal classification is determined by the captured contaminants and local law, not by the unused media alone.

Standard Packaging

Packaging	Weight of product	Quantity/ pallet	Gross Wt./ pallet
Drum (60 L)	42 kg	18	810 kg

★Other packaging can be considered on request

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