



**THE NEW TREND IN OIL & GAS :
SAFEGUARDING CO₂ PIPELINES BY
REMOVING NOX, SOX, AND H₂S**

A business case study

krajete
On Behalf of Nature.



Business Background & Challenges Impact

These challenges were taking a toll on the company's profitability and its ability to compete effectively. The need for a transformational change was evident to ensure the company's long-term survival and success.

The Company

An undisclosed major oil producer decided to adopt carbon capture measures for one of its onshore facilities. The site processes large volumes of CO₂—nearly 100,000 m³/h—intended for transport through a dedicated pipeline.

Key Challenges

Testing revealed that even small concentrations of NO_x, SO_x, and H₂S were starting to corrode compressors and downstream pipes, which were not originally designed to handle acidic conditions. Potential repairs or retrofits would later cost many millions in capital expenditure.

The Corrosion Issue In Pipelines

Initial research confirmed that even a low concentration of 10 ppm of NO_x, SO_x, and H₂S could combine with moisture to form corrosive acids inside the line, raising fears of internal corrosion and unexpected failures.

Engineering estimates showed that a worst-case scenario—if corrosion took hold—could force partial pipeline replacements or major overhauls every few years, potentially costing several millions each time in capital expenditure.

Additionally, the plant risked unplanned downtime, with each day of idled operations translating into significant revenue losses and potential financial penalties under tightening emissions regulations.





Krajete's regenerative adsorber solution:

● 1. A multi-gas capturing technology

We take a holistic approach to removing all key impurities—NO_x, SO_x, H₂S etc.—rather than tackling them one at a time. We install the adsorber upstream, capturing flue gases before the CO₂ even enters the pipeline. This positioning fully protects the pipeline and compressors from corrosion

● 2. A mild, regenerative process

Unlike single-use or chemical scrubbing systems, our unit operates through a low-stress, self-renewing adsorption process. It physically binds pollutants to specially developed adsorbent materials, and once saturated, the adsorber is thermally regenerated on-site.

● 3. Core technology

Our adsorber platform is a physisorption-based system developed to:

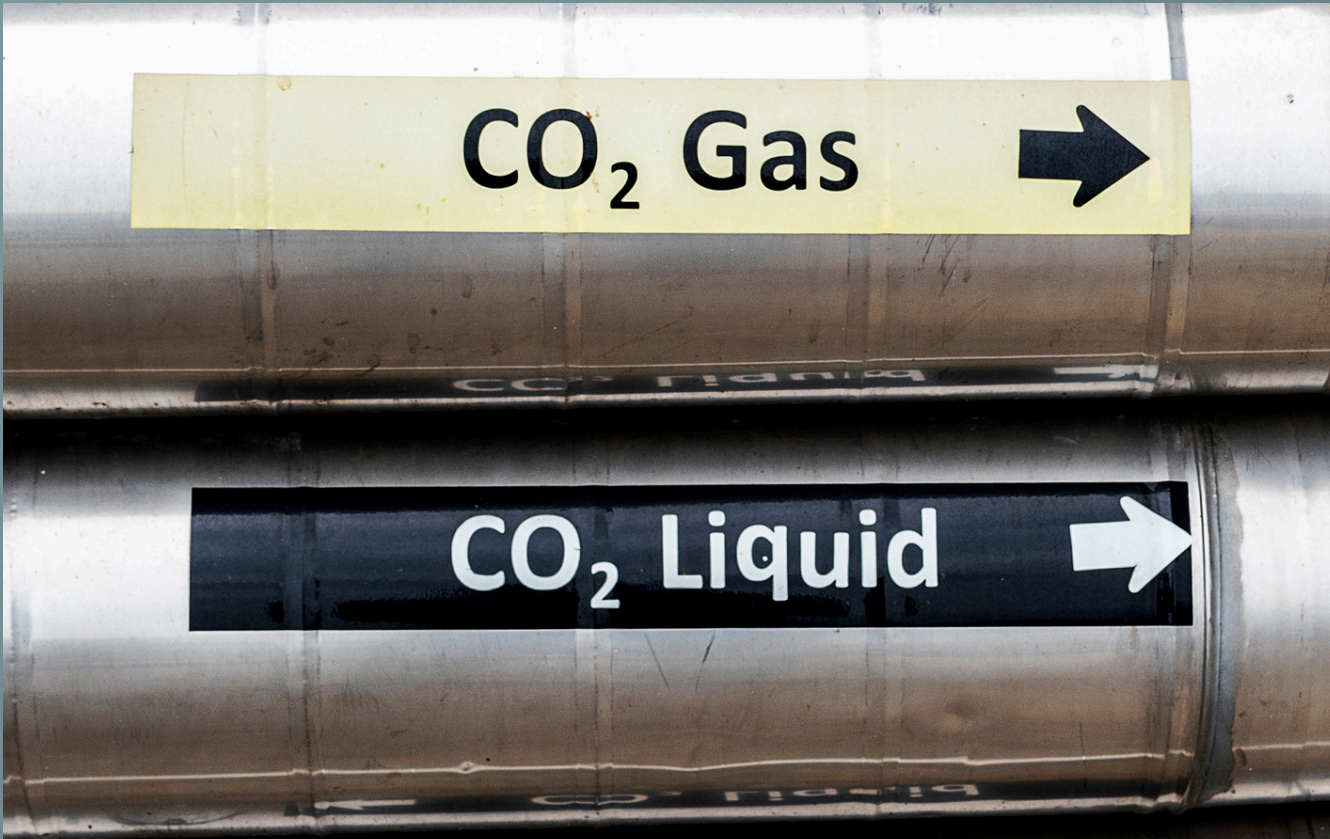
- Selectively capture NO_x at both moderate and higher pressures, even in the presence of CO₂ and water vapour.
- Regenerate & reuse the adsorbent by thermally desorbing the bound NO_x, which can then be recovered or converted to valuable by-products like nitric acid.
- Handle additional Impurities such as SO_x, H₂S, or unburnt hydrocarbons, offering a single-step “fine polishing” solution that meets stringent ppm or sub-ppm requirements

● 4. Return to service

The released NO_x, SO_x, and H₂S can then be recovered for reuse (e.g., in fertiliser production), reducing waste while creating potential new revenue. This all-in-one solution avoids complicated multi-stage purification lines and ensures minimal downtime—making it both an environmentally responsible and cost-effective way to keep CO₂ transport infrastructure running safely over the long term.



Why our NOx adsorption beats SCR – Technically and financially



Traditional SCR systems come with baggage—high temperatures, high energy bills, messy ammonia logistics, and expensive catalyst maintenance.

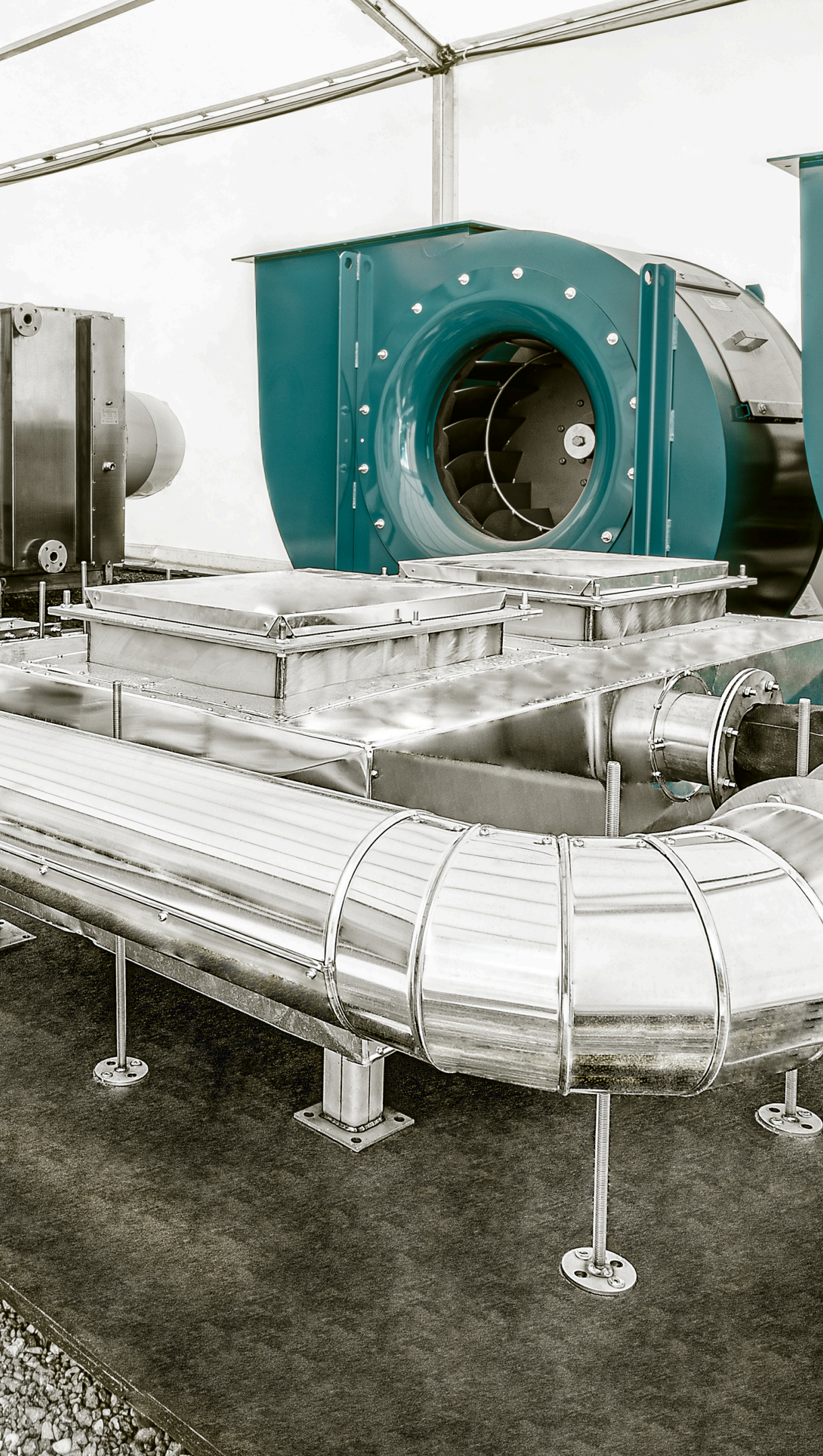
We flip the script by capturing NOx efficiently even at ambient or sub-zero temperatures, without needing reheaters, catalysts, or dosing systems. Our solution is dry, compact, and modular, meaning faster installs, lower footprint, and easier retrofits.

For plant operators, this translates into savings of €100k–250k on capex and up to €50k–100k in annual operating costs—while also avoiding ammonia slip, downtime, and compliance headaches. In short: less complexity, more value, and a cleaner path to NOx compliance and valorisation.

SCR vs Krajete NOx Adsorption – Technical & Financial Comparison



Criteria	SCR (Selective Catalytic Reduction)	Krajete NOx Adsorption Technology	Estimated Monetary Benefit of Krajete Solution
Minimum operating temperature	Requires ≥250 °C for efficient operation	Operates effectively at very low temperatures – from below 0 °C to ~40 °C	Saves energy costs by avoiding flue gas reheating – potential savings of €20–40k/year for small plants
Sensitivity to catalyst poisoning	High – dust, alkali metals, sulfur compounds can deactivate catalyst	Low – dry system without catalytic surfaces	Avoids frequent catalyst replacement – savings of €10–30k/year
Effectiveness at low NOx concentrations	Inefficient below ~100 ppm	Highly effective – adsorbs NOx even at <1 ppm	Reduces costs of overdosing ammonia at low NOx levels – savings of €5–15k/year
Need for ammonia or urea injection	Yes – requires urea or ammonia dosing system	No dosing system required	Eliminates ammonia handling and storage – compliance + savings of €5–10k/year
Space and integration requirements	Large footprint, especially for retrofits	Compact and modular; retrofits possible	Compact design reduces retrofitting costs – savings of €20–50k in space-constrained retrofits
Energy demand (for reheating)	Often requires gas reheating – high energy cost	No reheating needed – passive process	No reheater needed – capex reduction of €50–100k
Maintenance frequency and complexity	High – catalyst replacement, cleaning, slip control	Low – simple process design and robust long-lasting material	Minimizes O&M costs – lower maintenance burden, saves €5–10k/year
Ammonia slip risk	Yes – can exceed limits in transient conditions	None – no ammonia involved	No ammonia slip management – avoids penalties and extra monitoring (~€5k/year)
Startup time and flexibility	Slow – requires warmup of catalyst	Instant-on; no warmup required	No warm-up time – efficient for intermittent processes; reduces downtime
Capital cost for retrofit	High – especially in older plants or tight spaces	Moderate to low – especially for modular retrofits	Lower upfront investment compared to full SCR – saves €100–250k per installation
Dry operation / no wastewater	No – condensate or wash water needs handling	Yes – entirely dry system	Dry system – no water treatment costs, savings of €2–5k/year
Scalability for small emitters	Poor – economically unfeasible for small flows	Excellent – easily scaled to small or batch sources	Scalable for small emitters – opens opportunities where SCR is not economically viable



Project outcomes

- Lowered CAPEX

Avoiding expensive maintenance and operations downtimes by preventing corrosion in pipelines and compressors. Our smooth, regenerative process helped the client save millions in capital expenditure.

- Protected Asset

Oil & Gas pipelines and compression systems weren't built for acidic or corrosive flows. With our holistic gas-purification solution, the client is now able to maintain asset integrity, extending equipment life and reducing downtime.

- Removed Impurities

NO_x and SO_x are now removed at the lowest ppm levels, ensuring cleaner CO₂ pipelines and preventing costly maintenance.

- Valorised Impurities

Rather than scrubbing and discarding impurities, our system recovers these contaminants, providing the client with a new revenue stream (nitric acid production).

- Key Takeaways

This is a masterpiece of a circular economy case where impurities are removed and repurposed as a product while cutting costs.





Overcoming Obstacles

The facility now benefits from a simpler, circular approach to impurity removal.

No single-use catalysts, no additional chemical by-products, just a robust, regenerative system that keeps CO₂ lines clean and safe while adding financial upside from recovered resources.

This shift highlights how forward-thinking oil companies can stay competitive and protect their infrastructure at the same time.

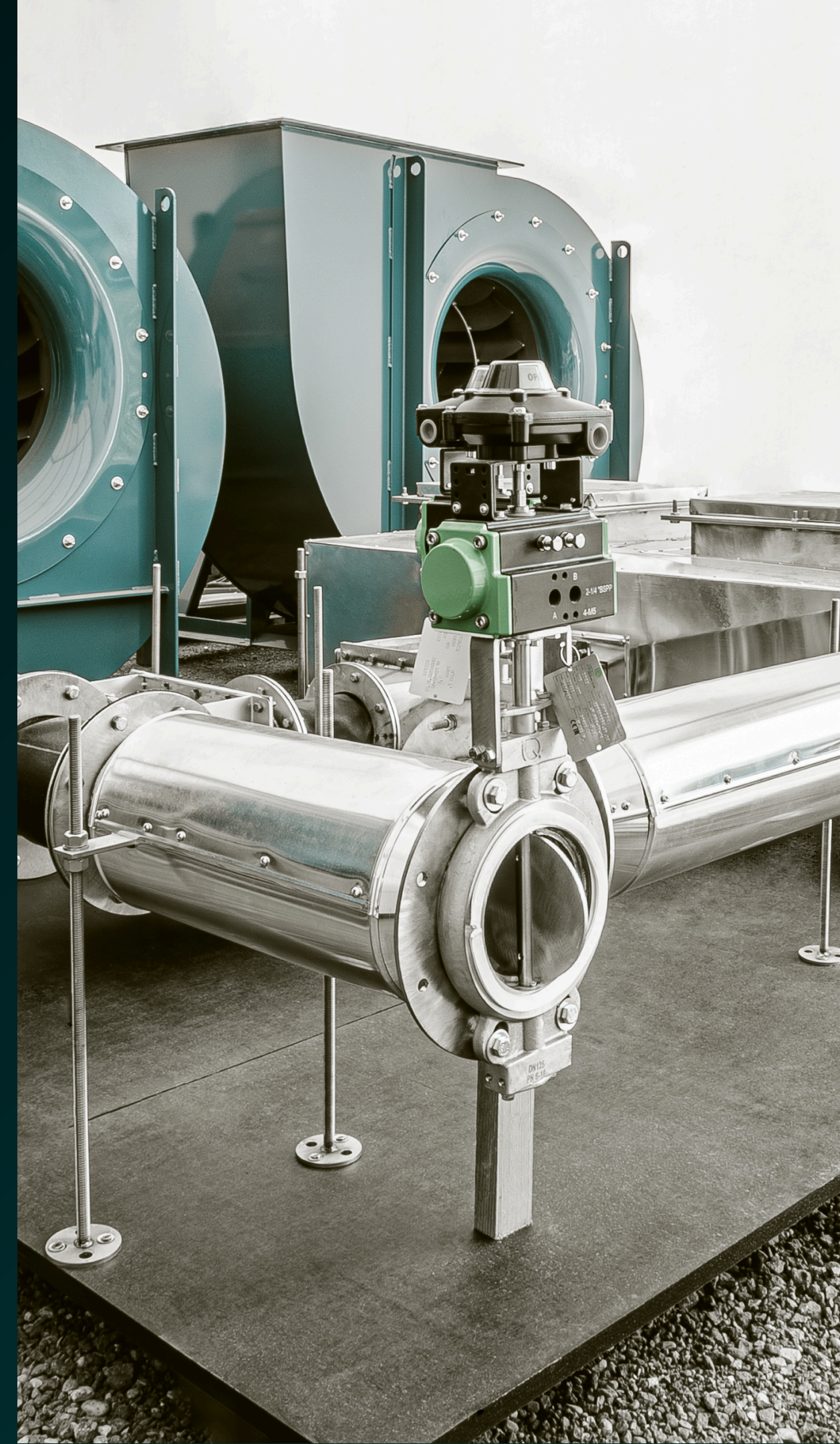
Final Quote

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Working with Krajete gave us far more than a simple pollution filter. We drastically reduced the risk of corrosion in our CO₂ line and found new ways to monetise the captured pollutants. This has been a decisive move for us—our pipeline and compressors are now much better protected, and we're already seeing a clear path to a strong return on investment.

A. Gonzalez - Lead process engineer at the undisclosed facility.

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A photograph of an industrial facility, likely a refinery or chemical plant, at dusk. The sky is a mix of purple and blue. Several tall distillation columns and large storage tanks are visible, illuminated by artificial lights. The foreground shows a large, white, dome-shaped storage tank.

FAQs



1. Can your adsorbent system selectively remove low ppm levels of NO_x from a CO₂ stream (gas phase or dense phase at higher pressures)?

Yes. This is our main competitive advantage, emerging from a regenerative NO_x abatement system originally developed for car emissions. Our patented hydrophobic adsorber targets and selectively captures NO_x in a CO₂-containing stream. Once saturated, the adsorber is heated to release concentrated NO_x, which can then be recovered for applications such as nitric acid or fertiliser production. This process is circular rather than sacrificial, so the adsorber can be reused after regeneration.

2. Can your adsorbent system selectively remove low ppm levels of SO_x under similar conditions?

Yes. In many cases, the same adsorber technology also captures SO_x. Its co-adsorption ability means NO_x and SO_x can both be removed from a CO₂-rich stream. The system then regenerates in the same manner, releasing concentrated SO_x for potential reuse.

3. What about low ppm levels of H₂S?

Yes. Our reference client in the UK uses an identical adsorber to remove H₂S from gas streams in synthetic diamond production, which relies on our patented biomethanation process. The same adsorption-and-regeneration framework that applies to NO_x and SO_x can be adapted for H₂S removal.

4. How can this technology be integrated into a CO₂ transportation infrastructure (e.g. pipelines)?

We recommend installing our NO_x, SO_x, and H₂S adsorber system as early as possible in the process—ideally at the source—before the CO₂ enters the pipeline. This approach ensures the pipeline operates with a high-purity CO₂ stream. We typically work with clients to understand their pipeline specifications and confirm whether deployment is best done upstream (pre-capture) or downstream (post-capture) depending on site-specific conditions.

5. What is the efficiency of your technology in removing NO_x, SO_x, and H₂S under industrial conditions?

Very high. Removal rates can reach 99.9% for NO_x, SO_x, and H₂S. This precise “fine polishing” meets stringent regulatory needs. Clients from regions with strict NO_x rules appreciate that we can reduce NO_x to as low as 1 ppm at potentially lower operating costs compared to SCR solutions.

6. What about the maintenance effort at industrial scale?

Typically, it involves:

- Periodic Inspection: Annual checks of valves and pipelines.
- Regeneration: The adsorber is thermally regenerated when it's fully saturated—often after about two weeks of continuous operation—requiring moderate heat input.
- No Consumables: Unlike one-way scrubbing solutions, there is no constant use of reagents or catalysts.
- Process Validation: We often recommend real-gas sampling to ensure the adsorber configuration precisely matches the actual gas composition (i.e., avoiding synthetic gas pitfalls).

Ready to Protect Your Pipeline ?

Get in touch to learn how Krajete can tailor a CO₂ purification system for your site, safeguarding pipelines, cutting costs, and meeting the toughest emissions targets.

Suggested Next Steps

- Gas Sampling: Capture real flue gas samples to confirm composition and identify the optimal adsorbent.
- Lab/Pilot Trials: Conduct scaled tests with our bench or skid-mounted pilot systems to verify removal rates under real conditions.
- Engineering Integration: Work with your EPC contractor to design a tailored DeNOx system that fits your pipeline or CCS infrastructure requirements.

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