



Contamination Removal for Compressor Protection

Compressors are among the most critical and capital-intensive assets in the refinery, petrochemical, gas processing, and gas transmission industries. Solid particulate and liquid aerosol contamination in gas streams represent a leading but often underappreciated threat to compressor reliability, operational efficiency, and service life. Field data collected across hundreds of sites consistently shows that conventional separation equipment — knock-out pots, centrifugal separators, vane separators, and mesh pads — routinely fails to remove submicron contaminants that cause valve fouling, cylinder damage, blade salting, and costly unscheduled shutdowns.

This white paper presents the engineering case for deploying high-performance liquid/gas coalescing filtration both upstream and downstream of compressor units. It reviews the mechanisms by which contamination damages reciprocating and centrifugal compressors, surveys available separation technologies, and provides field evidence and commercial case study data supporting the adoption of high-performance filtration and separation equipment such as Pall Corporation's HFG and SepraSol Plus product lines. Three documented case studies — from a North Sea offshore platform, a US Midwest natural gas transmission station, and a Canadian refinery — demonstrate that properly designed coalescers and particulate filters can eliminate unscheduled shutdowns, extend maintenance intervals from months to years, and generate returns that far exceed the cost of the contamination control solution.

KEY FINDING

At least 20% of all reciprocating compressor failures are directly attributable to inlet gas contamination. High-performance coalescers can extend maintenance intervals to two years or more.

The Pall HFG high-flow gas filters and the SepraSol Plus liquid/gas coalescers represent the current state of the art in compressor inlet and outlet gas conditioning. Innovations such as patented fluorocarbon surface treatment and high flux designs differentiates them

from conventional contamination control equipment by enabling higher gas throughput through fewer elements, lower differential pressure, and improved liquids & solids removal performance.

1. Introduction: The Hidden Cost of Compressor Contamination

Compressors operate at the heart of gas processing, refining, and transmission infrastructure. Whether compressing feed gas for a hydrocracker, circulating hydrogen in a refinery loop, or moving natural gas along a pipeline, compressor reliability directly determines plant throughput and profitability. Compressor outages — even brief ones — carry penalties that extend far beyond direct repair costs.

A survey of 200 reciprocating compressor operators found that an unscheduled shutdown in hydrogen gas service costs between \$40,000 and \$100,000 (USD) per day in lost production revenue — and that figure does not include labor, parts, or contract maintenance costs. Despite this, the root causes of many failures — solid particulates and liquid aerosols in the process gas stream — are often managed with legacy equipment that was not designed to remove the fine, submicron contamination that reaches compressor components. The typical response to compressor contamination problems has been to increase preventive maintenance frequency: inspecting and rebuilding valves, piston rings, and cylinders on six-month schedules rather than the design intent of two years or longer. This approach is costly, disruptive, and ultimately ineffective if the root cause — inadequate inlet gas conditioning — is not addressed. High-performance liquid/gas coalescers offer a proven engineering solution that resolves contamination at its source.

OPERATIONS NOTE

A survey of 200 compressor users identified fouled inlet valves as the primary failure mode in reciprocating compressors, with pressure packings second. The leading process improvement recommended was installation of improved liquid/gas coalescing systems.

2. Types of Contamination in Gas Streams

Gas streams in industrial service carry two fundamental classes of contaminants: solid particulates and liquid aerosols. Both classes are harmful to compressors, often co-exist in the same stream, and each requires tailored separation strategies. Understanding the nature, source, and size distribution of these contaminants is essential to selecting appropriate filtration equipment.

2.1 Solid Particulates

Solid contaminants in gas streams originate from multiple sources including pipeline and vessel corrosion, process upsets, and carryover from upstream unit operations. The most common solid species encountered in gas service are:

- Iron oxides and iron sulfides — corrosion products from steel piping and vessels
- Salts — sodium chloride and other inorganic salts carried from produced water or process condensate
- Silt and mineral fines — from formation ingress or construction debris
- Polymerized hydrocarbons — sludge-like deposits formed from cracked or oxidized process fluids
- Catalyst fines — from upstream reactor or reforming units

Field sampling conducted by Pall Corporation at compressor inlets across gas processing plants, gas transmission stations, and refineries found total suspended solids ranging from less than 0.05 g/mmscf to over 50 g/mmscf. Crucially, the majority of test sites recorded solids in the 1 to 50 g/mmscf range — even when operating downstream of conventional separation equipment such as knock-out pots, filter-vane separators, or mesh pads. This demonstrates that conventional equipment is insufficient to protect the compressor from fine solid contamination.

2.2 Liquid Aerosols

Liquid contamination in gas streams exists across a wide spectrum of drop sizes, from large slugs visible to the naked eye down to submicron mist that behaves nearly as a gas. Liquid species encountered in compressor service include:

- Hydrocarbons — refinery product carryover, lube oil mist, condensate
- Aqueous liquids — produced water, process water, dissolved salts, caustic, and acid solutions
- Alcohol and glycol — from upstream dehydration processes

- Ammonia chloride solutions — in reformer and platformer hydrogen recycle streams

The same Pall field survey found liquid aerosol concentrations at compressor inlets ranging from less than 0.5 liter/mmscf to over 500 liter/mmscf, with most measurements in the 2 to 500 liter/mmscf range. Significantly, these measurements were taken downstream of multiple conventional separation stages — confirming that the fine aerosol fraction (sub-10 μm) passes through knock-out drums, centrifugal separators, and mesh pads essentially unimpeded. The submicron fraction, which cannot be removed by inertial impaction-based separators, is precisely the fraction that penetrates deepest into compressor internals and causes the greatest damage.

IMPORTANT

Liquid aerosol concentrations at compressor inlets frequently range from 2 to 500 liter/mmscf — even after passing through conventional separation equipment. Fine mist in the 0.1–10 μm range is effectively invisible to knock-out drums, cyclones, and mesh pads.

3. How Contamination Damages Compressors

The damage mechanisms differ between reciprocating and centrifugal compressors, reflecting their different operating principles and internal geometries. However, both types are significantly affected by solid particulate and liquid aerosol contamination, and both benefit substantially from high-performance inlet filtration.

3.1 Reciprocating Compressors

Reciprocating compressors operate on the same fundamental principle as a piston engine: gas enters the cylinder through intake valves, is compressed by a piston, and is expelled through discharge valves. The valves are the most contamination-sensitive component in the assembly. Contamination damage to reciprocating compressors follows a well-understood progression:

1. Valve fouling — Solid and liquid contaminants accumulate on valve seats and discs, causing the valves to stick or to bypass partially. Fouled valves reduce the compression ratio, increase power consumption, and eventually fail entirely.

2. Piston ring damage — Abrasive particulate that passes through the valves acts as a lapping compound between the piston rings and the cylinder wall, accelerating wear and reducing ring sealing efficiency.
3. Cylinder wall scoring — Solid particles embedded in liquids create a slurry that scores the cylinder bore, increasing blow-by losses and forcing early overhaul.
4. Pressure packing deterioration — Contaminated gas accelerates wear of the rod packing seals, leading to gas leakage and the need for frequent packing replacement.

Research data indicates that the primary failure mode in reciprocating compressors is valve failure, followed by pressure packing degradation — both directly attributable to inlet gas contamination. Without adequate filtration, maintenance cycles are typically compressed to every six months or less. With high-performance coalescing filtration, properly designed systems have demonstrated two-year maintenance intervals.

3.2 Centrifugal Compressors

Centrifugal compressors accelerate the process gas through high-speed rotating impellers and then compress it through stationary diffusers. While generally more tolerant of contamination than reciprocating machines, centrifugal compressors are still vulnerable to several distinct damage pathways:

5. Blade fouling — Dissolved salts in liquid aerosols crystallize on the rotating impeller blades as liquids evaporate under compression. Accumulated deposits partially block the gas flow path, increasing power consumption and reducing throughput.
6. Rotor imbalance — Uneven salt or hydrocarbon deposits on impeller blades create aerodynamic and mass imbalance. Imbalance in a high-speed rotor generates vibration that, if unchecked, can lead to catastrophic bearing and seal failures.
7. Diffusor fouling — Particulate and liquid deposits on the stationary diffusers reduce stage efficiency and increase the risk of compressor surge.
8. Seal damage — Abrasive particulates accelerate wear of non-contact labyrinth seals, reducing their effectiveness and increasing internal gas recirculation losses.

Centrifugal compressors are typically taken offline for cleaning at regular intervals — a practice that represents substantial direct costs and lost production revenue. As demonstrated in the North Sea case study presented in Section 8, installation of a high-

performance coalescer upstream of a centrifugal compressor completely eliminated the salt deposition problem that was costing over \$1,000,000 per year.

4. Filtration Before and After the Compressor

Effective compressor protection requires a systems approach to gas conditioning that addresses contamination both at the compressor inlet and, in many configurations, at the compressor discharge. The requirements and equipment selection rationale differ for each location.

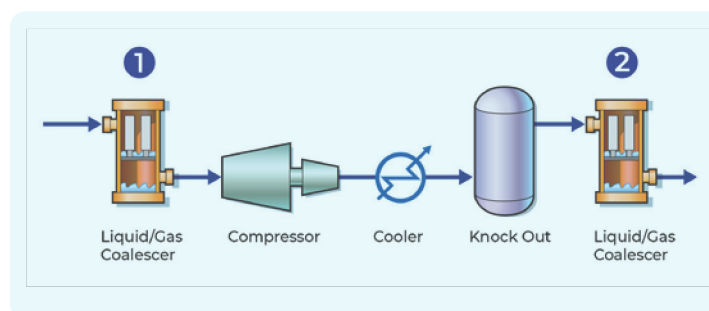


Figure 1: Compressor layout with upstream (1) and downstream (2) Liquid/gas coalescer solutions

4.1 Pre-Compressor (Inlet) Filtration

Inlet filtration is the primary line of defense for compressor protection. The goal is to remove both solid particulates and liquid aerosols from the process gas before they can reach the cylinder valves, impeller blades, and sealing surfaces. Inlet filtration must contend with the full range of contaminant size distributions — from 300+ μm slugs down to 0.1 μm fine mist — and must do so reliably across varying flow rates, temperatures, pressures, and liquid loadings.

A well-engineered inlet filtration system for a compressor typically consists of two or more stages:

- **Stage 1** — Bulk liquid removal: A knock-out drum or gravity settler to remove liquid slugs (> 300 μm) and protect downstream equipment from slug loading.
- **Stage 2** — Intermediate separation: A centrifugal separator, vane separator, or mesh pad to remove the coarser aerosol fraction (> 10 μm) and reduce the liquid loading on the final-stage coalescer.
- **Stage 3** — Fine aerosol removal: A high-efficiency liquid/gas coalescer, such as the Pall SeptraSol Plus, to remove submicron and low-micron aerosols that pass through all upstream stages. This is the critical stage for compressor protection.

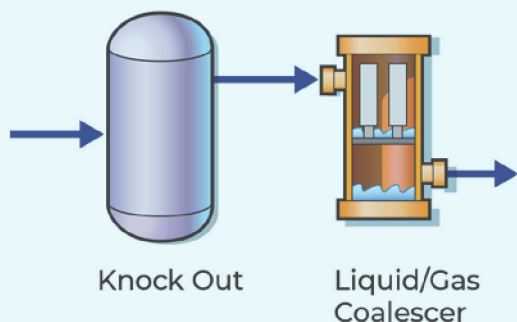


Figure 2: Typical liquids + particles filtration systems design. The "stage 2" intermediate separation can typically be integrated into the KO drum or coalescer vessel

While liquid/gas coalescer are suitable for both liquid and solid separation, in instances where a gas stream solely face solid particulate challenges it may be more economical, both in OPEX and CAPEX to use a gas particulate filter. Specifically for solid particulate control, a high-efficiency gas filter — such as the Pall HFG series — is typically placed upstream of or integrated with the coalescer system to remove abrasive particulates before they can foul the coalescer medium or enter the compressor.

DESIGN PRINCIPLE

High-efficiency coalescers are designed for inlet liquid concentrations as high as 1,000 ppmw (0.1%) and in best cases should be preceded by bulk liquid removal equipment. Outlet concentrations as low as 0.003 ppmw have been demonstrated in commercial service from Pall's SepraSol Plus L/G coalescers.

4.2 Post-Compressor (Discharge) Filtration

Post-compressor filtration serves multiple purposes and is equally important in many process configurations. At the discharge of a compressor, the gas stream carries contamination from two sources: carryover from the inlet that passed through the compressor,

and contamination introduced by the compressor itself — primarily compressor lubricating oil mist and, for reciprocating machines, wear debris from cylinders and packing.

Downstream equipment that benefits from post-compressor filtration includes:

- Amine and glycol contactors — Hydrocarbon aerosols cause foaming in absorption systems, significantly reducing their dehydration and treating efficiency.
- Molecular sieve beds — Liquid carryover degrades the capacity and service life of molecular sieve dehydration units.
- Turbo-expanders and turbines — Liquid droplets and solid particles erode turbine blades and nozzles.
- Hydrotreater catalyst beds — Liquid and solid contamination poisons catalyst activity and increases reactor pressure drop.
- Burner nozzles — Liquid and particulate fouling causes nozzle erosion, flame instability, and emissions non-compliance.

In reciprocating compressor service, discharge gas can contain significant lube oil mist that must be removed before the gas enters downstream process units or is distributed as sales gas. High-efficiency coalescers in the discharge service position — again, the SepraSol Plus product line is the Pall recommendation — provide the same submicron removal performance as inlet units.

5. Separation Technology Comparison

Multiple liquid/gas separation technologies are available for compressor protection applications. Each operates on different physical principles, has distinct performance characteristics, and is suited to different stages of a multi-stage separation system. The table below summarizes the key operating characteristics of each technology type.

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Technology	Removal Rating	Min. Droplet Size	Turn-Down Ratio	Handles Slugs
Knock-Out Separator	Bulk only	> 300 μm	High	Yes
Centrifugal Separator	Moderate	> 10 μm	Poor	Yes
Vane Separator	Moderate	> 10 μm	Poor	Yes
Mesh Pad	Moderate	> 10 μm	Poor	Limited
Pall HFG / SepraSol Plus Coalescer	High Efficiency	$\geq 0.1 \mu\text{m}$	High	No (pre-filter needed)

The fundamental distinction between conventional separators (knock-out, centrifugal, vane, mesh pad) and high-efficiency coalescers lies in the separation mechanism. Conventional separators rely on inertial impaction — the tendency of larger, heavier droplets to deviate from the gas streamlines and strike a collection surface. This mechanism is inherently flow-dependent: as gas velocity decreases, inertial forces decrease, and separation efficiency drops sharply. This creates a poor turn-down ratio — the equipment performs adequately at its design flow rate but fails at reduced flows that are common during partial plant shutdowns and upset conditions.

High-efficiency liquid/gas coalescers, by contrast, separate contaminants through a combination of direct interception (sieving) and diffusional interception (Brownian motion). Both mechanisms actually improve as flow rate decreases — fine particles and droplets have more time to contact and be captured by coalescer fibers at lower velocities. This gives the coalescer a high turn-down ratio and allows it to maintain high separation efficiency across the full range of operating conditions.

The coalescer medium is constructed from fine glass fibers with pore sizes in the range of a few microns, allowing capture of aerosol droplets as small as 0.1 μm . The tapered pore structure — finest pores at the inlet face, progressively coarser pores toward the outlet — allows captured droplets to coalesce into progressively larger drops that eventually drain by gravity. Properly designed systems can achieve outlet liquid concentrations as low as 0.003 ppmw.

ENGINEERING NOTE

The turn-down ratio of a separator is the ratio of its design flow rate to the minimum flow rate at which it still performs effectively. High-efficiency coalescers have high turn-down ratios — separation efficiency actually increases as flow decreases. Centrifugal separators and mesh pads have poor turn-down ratios and lose effectiveness significantly at reduced flows.

6. Field Data: Contamination Levels at Compressor Inlets

Pall Corporation has conducted extensive field measurement at compressor inlets across gas processing plants, gas transmission stations, and refineries. The measurement program used two primary methods:

- Liquid aerosol measurement — A pilot-scale Pall sidestream coalescer test stand was used to extract a small sidestream (approximately 4 acfm) of the process gas. The test stand included a coalescer housing, liquid collection sump, differential pressure gauge, orifice metering, and needle valves for flow control. The concentration of liquid aerosol was calculated from the volume of liquid collected and the total gas throughput over the test period of 0.5 to 2 days.
- Solid particulate measurement — An inline field test method collected gas-phase solids on pre-weighed analysis membranes rated at 0.01 μm at system conditions. After sampling for 4–8 hours, membranes were extracted with filtered solvent to remove any liquid contaminants, dried, and weighed. Total suspended solids were calculated from the weight difference and gas throughput.

A critical finding from this measurement program was the importance of extended test duration: fluctuations in gas contaminant levels are commonplace, and short measurement windows are not representative of actual operating conditions. Running the liquid measurement over one to two days captured slug events and fluctuations that would be missed by brief sampling campaigns.

The combined solid and liquid field data paint a consistent picture:

- Liquid aerosol concentrations at compressor inlets ranged from < 0.5 liter/mmscf to > 500 liter/mmscf, with the majority of measurements falling in the 2 to 500 liter/mmscf range. High concentrations were found in both hydrocarbon gas and hydrogen service.

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- Solid particulate concentrations ranged from < 0.05 g/mmscf to > 50 g/mmscf, with most measurements in the 1 to 50 g/mmscf range.
- Critically, all measurements were taken downstream of existing conventional separation equipment — confirming that knock-out pots, filter-vane separators, and mesh pads are inadequate as standalone compressor protection devices.

These field results provide the empirical foundation for the engineering recommendation that high-efficiency coalescers are required as the final stage of any compressor inlet separation system. Conventional equipment is effective for bulk liquid removal but cannot address the fine aerosol fraction that causes compressor damage.

FIELD DATA SUMMARY

Extensive measurement data across gas processing, transmission, and refinery sites confirms that significant solid and liquid contamination reaches compressor inlets even after multiple stages of conventional separation equipment. Only high-efficiency coalescers reliably remove the submicron fraction missed by existing bulk filtration.

7. Case Studies

The following three case studies document the commercial application of Pall high-performance liquid/gas coalescers for compressor protection. Each case study presents the process context, the contamination problem encountered, the Pall solution implemented, and the measurable operational and economic outcomes achieved. All case studies are drawn from the Pall Corporation Scientific and Technical Report GDS116 (Wines & Lorentzen, 1999).

8.1 Case Study 1: North Sea Offshore Platform

CASE 1 — North Sea Offshore Platform Centrifugal Compressor Natural Gas	
Process	Offshore natural gas processing platform supplying the UK gas grid. Approximately 363,000 kg/hr of natural gas processed at 45.5 bar absolute and 32°C through a centrifugal compressor.
Problem	High concentration of produced water from wells, saturated with salt, was passing through upstream separation into the centrifugal compressor. Salt crystallized inside the compressor casing, causing trip-outs. Approximately 0.5 tons of salt deposited every six months. Each incident required costly cleaning, rebuilding, and compressor downtime — affecting both the platform and the onshore UK processing plant. Estimated non-conformance cost: over \$1,000,000 per year including unscheduled repairs, lost gas production, and potential contract penalty payments.
Solution	Pall SepraSol high-performance liquid/gas coalescer system designed to reduce inlet free liquid from 1,860 ppmw to 0.003 ppmw. Three-stage system: gravity knockout sump, mesh pad (second stage), and 130 SepraSol coalescing cartridges (final stage). Single vertical vessel of approximately 2 m diameter, 9.3 m overall height, BS5500 Category 1 design code, 24-inch inlet and outlet nozzles. Complete system weight: 77 tons.
Outcome	Complete elimination of compressor trip-outs and salt deposition following installation. No unscheduled maintenance required. Full user satisfaction confirmed. System has operated flawlessly since installation.
Savings	Annual savings in excess of \$1,000,000 through elimination of unscheduled repairs, production losses, and potential contractual penalties.

8.2 Case Study 2: USA Midwest Natural Gas Transmission

CASE 2 — USA Midwest Gas Transmission | Reciprocating Compressors | Natural Gas

Process	Natural gas compressor station containing two train reciprocating compressors processing an estimated 14 mmscfd. Gas fed to a triethylene glycol (TEG) dehydration plant prior to sales distribution.
Problem	Solid and liquid aerosol contamination were passing through the existing coalescers, causing fouling of the compressor valves and resulting in unscheduled shutdowns for repairs. Cost to rebuild the compressor — including downtime, labor, parts, and lost production — exceeded \$250,000 per incident. Existing coalescers were also fouling rapidly, requiring element replacement every 6–8 weeks, adding to maintenance burden and cost.
Solution	Pall SepraSol high-performance liquid/gas coalescers with patented fluorocarbon surface treatment (simultaneously hydrophobic and oleophobic) installed upstream of the compressor in the existing 24-inch diameter vessel, holding 19 coalescer cartridges. Contaminant removal reduced to undetectable limits.
Outcome	Zero unscheduled compressor shutdowns since installation of the SepraSol coalescers. Element service life extended to 12–13 months versus the previous 6–8 week replacement cycle. Results were so compelling that the gas transmission company installed Pall SepraSol coalescers in all of its other coalescing units across the network.
Savings	Elimination of \$250,000+ rebuild costs per incident, plus reduction in coalescer element replacement costs from approximately 8x per year to less than 1x per year.

8.3 Case Study 3: Canadian Refinery — Recycle Hydrogen

CASE 3 — Canadian Refinery | Reciprocating Compressor | Hydrogen Recycle

Process	Reciprocating compressor on a recycle hydrogen gas stream at a Canadian refinery. Hydrogen is feed to a high-pressure hydrocracker. Flow rate: 57.5 mmscfd. Operating conditions: 1,800 psi, 120°F. Gas originates from a platforming unit with knockout pot and mesh pad separator.
Problem	Excessive fine hydrocarbon aerosols were carrying over from the platformer unit through the mesh pad/knockout separator. Process upsets also introduced ammonia chlorides from organic chloride injection used to enhance catalytic activity. The reciprocating hydrogen recycle compressor experienced valve and cylinder fouling caused by polymerized hydrocarbon sludge, resulting in unscheduled shutdowns every 2–3 months. Annual compressor repair cost: \$375,000. Additional margin losses of \$22,000 per day of shutdown.
Solution	Pall SepraSol high-efficiency liquid/gas coalescer installed upstream of the recycle compressor. Carbon steel construction, design pressure 2,050 psig to ASME Code Section VIII, Div. 1. Vessel: 12-inch diameter with 4-inch, 1500# RFWN flanges. Configuration: lower knockout sump for liquid slugs plus upper sump with four high-efficiency coalescer cartridges for fine aerosol removal. Compact installation representing a modest capital investment.
Outcome	Complete elimination of unscheduled compressor shutdowns following coalescer installation. Coalescer elements achieved average service life of 8–12 months, far exceeding the performance of the previous mesh pad/knockout system.
Savings	Annual savings of \$375,000 in compressor repair costs plus elimination of \$22,000/day production margin losses during previous 2–3 month shutdown cycles (equivalent to \$44,000–\$66,000 per avoided incident).

8. Economic Justification

The three case studies documented in Section 8 represent a cross-section of compressor types, process fluids, and operating environments. Despite their differences, each case study follows the same economic pattern: a modest capital investment in high-performance filtration eliminates recurring costs that are orders of magnitude larger. The economic justification for Pall HFG and SepraSol Plus equipment rests on four primary value drivers.

1. Elimination of Unscheduled Shutdown Costs

Unscheduled compressor shutdowns are the most significant economic consequence of inadequate inlet gas conditioning. In hydrogen service, a single day of unscheduled downtime costs between \$40,000 and \$100,000 in lost production revenue alone — before accounting for repair labor, parts, and any contractual penalties. In the three case studies presented, the total avoidable costs ranged from \$250,000 per incident to over \$1,000,000 per year. In each case, the Pall filtration solution eliminated unscheduled shutdowns entirely.

2. Extended Maintenance Intervals

Even compressors that do not experience catastrophic failures typically undergo intensive preventive maintenance on six-month or shorter schedules when inlet gas conditioning is inadequate. Valve replacement, piston ring inspection, cylinder measurement, and packing replacement are expensive activities requiring

specialized labor and significant parts costs. Pall field experience demonstrates that high-performance coalescers routinely extend compressor maintenance intervals to two years — a fourfold or greater improvement that directly reduces annual maintenance expenditure.

3. Extended Filtration Element Service Life

Conventional untreated coalescers in contaminated service require element replacement every 2 to 6 months. The fluorocarbon surface treatment on SepraSol Plus elements extends service life to 12–24 months in the same service conditions. Fewer element replacements mean less scheduled maintenance, less labor cost, less downtime, and lower consumed element cost per year. In Case Study 2, element replacement frequency dropped from approximately 8 times per year to less than once per year.

4. Protection of Downstream Assets

Post-compressor filtration using SepraSol Plus coalescers in the discharge position protects downstream process equipment from compressor lube oil carryover and any residual inlet contamination. Amine and glycol contactors, molecular sieve beds, catalyst beds, and turbine components all benefit from cleaner discharge gas. The cumulative value of protecting these downstream assets — which often represent investments in the tens of millions of dollars — further strengthens the economic case for comprehensive filtration.

Case Study	Annual Cost Before	Result After SepraSol Plus
North Sea Platform	> \$1,000,000/year	Zero shutdowns; salt deposition eliminated
USA Midwest Gas Transmission	\$250,000+ per rebuild event	Zero shutdowns; 12–13 mo. element life
Canadian Refinery (H ₂)	\$375,000 repairs + \$22K/day downtime	Zero shutdowns; 8–12 mo. element life

9. Conclusions and Recommendations

The evidence presented in this white paper — spanning laboratory coalescer performance characterization, extensive multi-year field measurement data, and three documented commercial case studies — leads to the

following engineering conclusions and operational recommendations for technical engineers and operations staff responsible for compressor asset integrity.

Conclusions

9. Contamination is the leading cause of compressor failure. At least 20% of reciprocating compressor failures are directly attributable to solid and liquid aerosol contamination in the inlet gas. Centrifugal compressors face equivalent threats to operational efficiency and reliability through blade fouling and rotor imbalance.
10. Conventional separation equipment is insufficient as standalone protection. Knock-out drums, centrifugal separators, vane separators, and mesh pads — while valuable as bulk liquid removal stages — cannot adequately remove the submicron and low-micron aerosol fraction that causes compressor damage. Field measurements confirm that high contamination levels persist downstream of multiple conventional separation stages.
11. High-efficiency coalescers are required for effective compressor protection. Only high-performance liquid/gas coalescers employing diffusional and direct interception mechanisms can reliably remove aerosol droplets to the 0.1 μm level and achieve outlet concentrations as low as 0.003 ppmw.
12. Surface treatment is the critical differentiator. The fluorocarbon surface treatment on Pall SepraSol Plus coalescer elements is not cosmetic — it fundamentally changes coalescer performance by enhancing drainage, preventing capillary flooding, reducing pressure drop, and extending service life threefold or more compared to untreated coalescers. All coalescers are not equal.
13. A multi-stage approach is required. The recommended system architecture is: (1) bulk knock-out, (2) intermediate separation (centrifugal or vane), (3) Pall HFG gas filter for solid particulate removal, and (4) Pall SepraSol Plus coalescer as the final high-efficiency stage. This staged approach protects the coalescer medium and maximizes system reliability.
14. The economics are compelling. All three case studies document that the installation cost of Pall filtration systems was recovered within the first operating period through elimination of compressor rebuild costs, avoided downtime, and reduced maintenance frequency.

Recommendations

- Audit all compressor inlet separation systems against actual inlet gas contamination levels using the Pall sidestream measurement methodology. Do not assume existing conventional separators are adequate based on design intent alone.
- Replace or upgrade final-stage separation to Pall SepraSol Plus high-efficiency coalescers in any service where compressor maintenance intervals are shorter than 18 months or unscheduled shutdowns have occurred.
- Install Pall HFG gas filters upstream of coalescers in services with known solid particulate contamination to protect coalescer element life.
- Evaluate post-compressor SepraSol Plus coalescer installation in services where downstream equipment (amine contactors, molecular sieves, catalyst beds, turbines) is experiencing fouling problems attributable to compressor discharge contamination.
- Engage Pall Corporation engineering resources for site-specific coalescer sizing using the validated modeling methodology for media velocity, annular velocity, and housing diameter determination described in this paper.

For more information on the Pall HFG high-flow gas filter series and the SepraSol Plus liquid/gas coalescer product line, contact your Pall Corporation regional sales engineer or visit www.pall.com.

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