



Pall Corporation

Contamination Control for

LNG

Production



Filtration. Separation. Solution.SM

Pall Contamination Control for LNG Production



Natural gas is a clean-burning fuel that emits lower levels of potentially harmful byproducts than heating oil or coal. Because it is clean and safe, its use is increasing in residential, commercial, and industrial settings. An important component of the world's energy supply, natural gas will continue to play a major role in the energy arena for years to come.

The Demand for Natural Gas Continues to Grow

In the United States, natural gas accounts for about one-quarter of all energy used. Its role is large and growing. According to the [2005 Annual Energy Outlook](#), prepared by the Energy Information Administration (EIA) of the U.S. Department of Energy, the demand for natural gas will increase more than 38 percent by 2025. This rapid rise in demand is due largely to increased consumption by new and existing electric generating plants running at higher capacities. Natural gas offers distinct advantages over generators fueled by coal; these include lower capital costs, lower emissions, and higher fuel efficiencies. Consumption in other large, energy-driven countries follows a similar pattern, since natural gas is increasingly being used to meet overall energy needs.

Reserves are Abundant but Remotely Located

The good news is that the world's natural gas reserves are extensive. These reserves will continue to satisfy the growing worldwide demand over the next several decades. The challenge, however, is that Russia, Iran, and Qatar combined hold more than 55 percent of the world's natural gas reserves. With over half of the reserves located in areas of the world far from consuming markets, the

biggest challenge becomes one of transportation. How can producers transport their natural gas to areas of need in a cost-effective, efficient way?

Economical Transportation of Natural Gas Relies on Liquefaction

The conversion of natural gas into liquid is called liquefaction and is achieved through refrigeration. Liquefaction reduces the volume of the gas by approximately 600 times, making it more economical to transport on a global scale. After the natural gas is converted to liquid, it is placed in reinforced containers and loaded onto specially designed ships, all meeting strict safety and security standards. When the ship reaches its destination, called a receiving terminal, the liquefied natural gas (LNG) is then converted back to gas and stored in specialty tanks. This is accomplished by warming the liquid during a process known as regasification. LNG is the answer for natural gas producers who need to ship their product over the ocean to countries where pipeline transportation is not feasible.

LNG Producers Use Filtration to Increase Production

The challenge for LNG producers is to maximize their output and, in some cases, expand their facilities to meet the increasing demand for natural gas. Filtration plays an important role in this effort. LNG producers can optimize their yields through the strategic placement of filtration products developed with advanced filtration and separation technologies. Pall will work with you to find the right solutions for the challenges presented by your specific LNG system.



Practical Solutions for Customers Around the Globe

Pall Corporation solves complex contamination, separation, and purification problems. We serve oil and gas, refinery, chemical, and polymer markets around the world. With Pall products and services, you can satisfy regulatory requirements and increase output while reducing total cost of ownership. Our enabling technologies help make customers' products better and safer, and may even make them possible.

Pall is much more than a filter company. We are fluid management specialists, leveraging our unmatched capabilities to make customers' operations more successful. Our expertise has enabled us to build a large library of proprietary core materials, which we can modify to separate, remove, or selectively capture the most elusive contaminants.

Pall has the ability to design, manufacture, and install economical, integrated systems as well as service them. Our systems can cost-effectively treat all of the incoming process and waste streams in your plant. We can offer these solutions to customers—whether in oil and gas pro-

duction, oil refining, gas processing, chemical production, or polymer processing—around the globe. By meeting critical needs, we build lasting customer relationships that grow stronger year after year.

To help our customers improve performance and reach higher goals, we have developed a comprehensive approach to treating your LNG plant, called Total Fluid ManagementSM (TFM), that leverages our strengths and provides you with real value.

Our customized system services include:

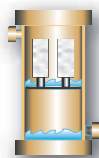
- Process audits/consultancy
- Customized product development
- Training seminars
- Testing/piloting
- System maintenance/service contracts

We invite you to learn more about Pall's wide array of products and customized system and productivity services for Total Fluid Management. Contact your Pall representative or visit us on the web at www.pall.com.

Filtration Recommendations for Liquefied Natural Gas

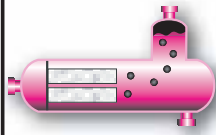


The adjacent schematic represents a typical flow of gas within an LNG production facility. Each Pall solution within the flow diagram is labeled and described in the charts that follow. For more detailed descriptions of Pall products used in the fuels and chemicals markets, please visit us on the web at <http://www.pall.com/chemical.asp>.



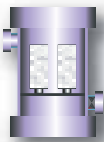
Pall Liquid/Gas Coalescers

Application	Challenge	Solution
1. Amine contactor protection	Prevent hydrocarbon and solid aerosols from contaminating the amine system, which could result in foaming, solvent losses, and off-specification gas.	Install liquid/gas coalescers to remove liquid droplets and solids from the gas before it enters the amine system.
2. Glycol contactor protection	Prevent amine, hydrocarbon, and solid aerosols from contaminating the glycol system, which could result in foaming, solvent losses, and off-specification gas. Recover carryover amine for reuse.	Install liquid/gas coalescers to remove liquid droplets and solids from the gas before it enters the glycol system.
3. Compressor protection	Improve reliability of the compressor by preventing fouling from liquid and solid aerosols.	Install liquid/gas coalescers to remove liquid droplets and solids from the gas before internal parts of the compressor are fouled or damaged.
4. Condenser/main LNG heat exchanger protection	Protect the refrigerant condenser and main LNG heat exchanger from fouling.	Install liquid/gas coalescers downstream of the compressor to remove carryover lube oil.
5. Molecular sieve drier protection	Increase cycle time between regeneration of the molecular sieve drier and extend the bed life.	Install liquid/gas coalescers to remove liquid droplets and solids from the gas before they foul the molecular sieve drier.



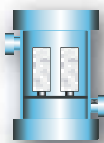
Pall Liquid/Liquid Coalescers

Application	Challenge	Solution
6. Rich amine	Improve the reliability of the amine regenerator by removing foulants in the amine solvent.	Install liquid/liquid coalescers to remove hydrocarbons from the amine solvent prior to the regenerator.
7. Condensate water	Provide condensate water free of hydrocarbons.	Install liquid/liquid coalescers to remove the hydrocarbon from the condensed water.



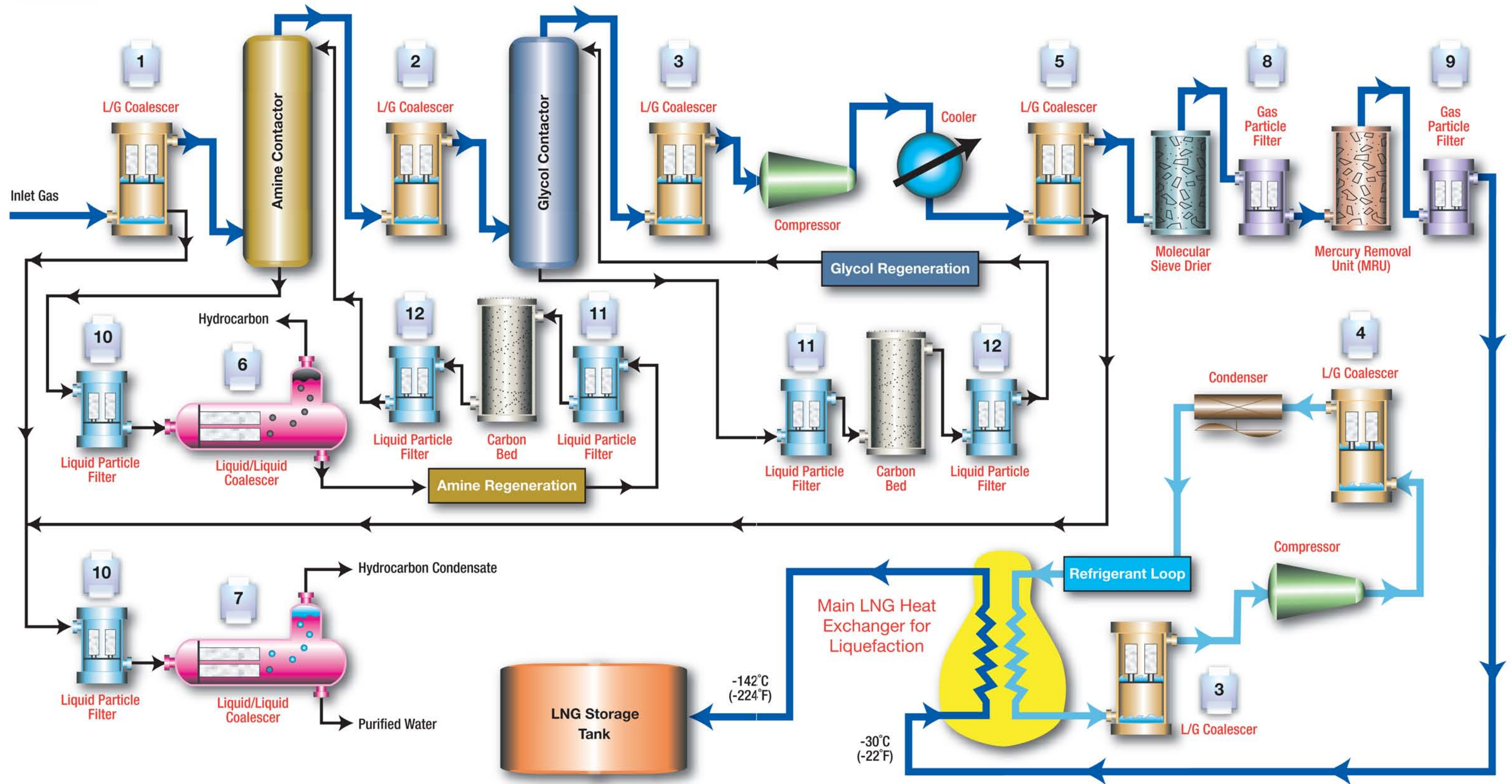
Pall Gas Particle Filters

Application	Challenge	Solution
8. Mercury removal unit (MRU) protection	Protect MRU bed from fouling with fine particles that carry over from the molecular sieve bed.	Install gas particle filters to effectively remove any carryover molecular sieve particles.
9. Main LNG heat exchanger protection	Protect the main LNG heat exchanger from fouling due to carryover MRU fines.	Install gas particle filters to effectively remove any carryover MRU fines.



Pall Liquid Particle Filters

Application	Challenge	Solution
10. Prefiltration prior to liquid/liquid coalescer	Ensure that the liquid/liquid coalescer has a service life of one year or more.	Install high-efficiency particle filters upstream of the liquid/liquid coalescers.
11. Upstream carbon bed in amine or glycol	Protect the carbon bed from plugging with solids.	Install high-efficiency particle filters upstream of the carbon bed.
12. Downstream of carbon bed in amine or glycol	Remove any carbon fines from the carbon bed that could bleed into the amine or glycol.	Install high-efficiency particle filters downstream of the carbon bed.



NOTE: Treatment options will vary and not all purification steps listed may apply. Contact your Pall representative for more information.

What Separation Equipment to Use



Pall Liquid/Gas Coalescers

Performing with maximum removal efficiency and economy, Pall liquid/gas coalescers reduce equipment downtime as well as decrease labor and maintenance costs. They have a unique fiber medium matrix that contains increasing pore sizes. This design allows small droplets in the incoming gas to merge (coalesce) into larger drops that are easier to separate. The medium enables single-stage coalescing to separate difficult liquid aerosols. Our liquid/gas coalescers are specially treated with a fluoropolymer coating to improve the drainage of liquids through the coalescer. As a result, smaller assemblies can be used, and up-front capital costs are minimized. The fluoropolymer treatment also lowers operating costs by allowing the coalescer to operate at a lower liquid saturated pressure drop and recover quickly from process upsets.

Pall products: *SepraSol™ liquid/gas coalescers, SepraSol Plus liquid/gas coalescers*



Pall Liquid/Liquid Coalescers

Pall liquid/liquid coalescers are designed to efficiently separate liquid/liquid emulsions. They are constructed of a variety of polymers and fluoropolymers, offering a wide range of compatibility. These high-efficiency coalescers are effective in systems with low interfacial tension without disarming or being compromised by the presence of surfactants. A patented vertical stack design is used with a coalescer/separator configuration, allowing an even flow distribution. This permits a high flow rate in a smaller assembly. With long service life, the coalescer cartridges require fewer change-outs, thereby reducing maintenance and disposal costs. A horizontal design is also available for use in oil from amine separations and for very low interfacial emulsions.

Pall products: *AquaSep® Plus liquid/liquid coalescers, PhaseSep® liquid/liquid coalescers*



Pall Gas Particle Filters

Small solid aerosols from gas streams, including desiccant fines, iron oxides, iron sulfides, and other particles, can foul instruments, valves, compressors, heat exchangers and other critical system components. Pall gas particle filters (GPF) are used to remove these particles, eliminating a primary source of the contamination that causes system failures.

Pall products: *Epocel® filters, Ultipor® filters, coreless Profile® filters*

Pall Liquid Particle Filters

Pall liquid particle filters (LPF) are used to remove contaminant particles from a liquid stream. The presence of these particles can lead to excessive pump wear, heat exchanger fouling, contactor foaming, and regenerator fouling. They can also shorten the life of the coalescer and carbon bed. The removal of these particles is preventive maintenance, which is an important part of an overall maintenance program.

Pall products: *Ultipleat® High Flow filters; Marksman™ filters; coreless Profile filters, Nexis® filters, and Claris® filters*



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