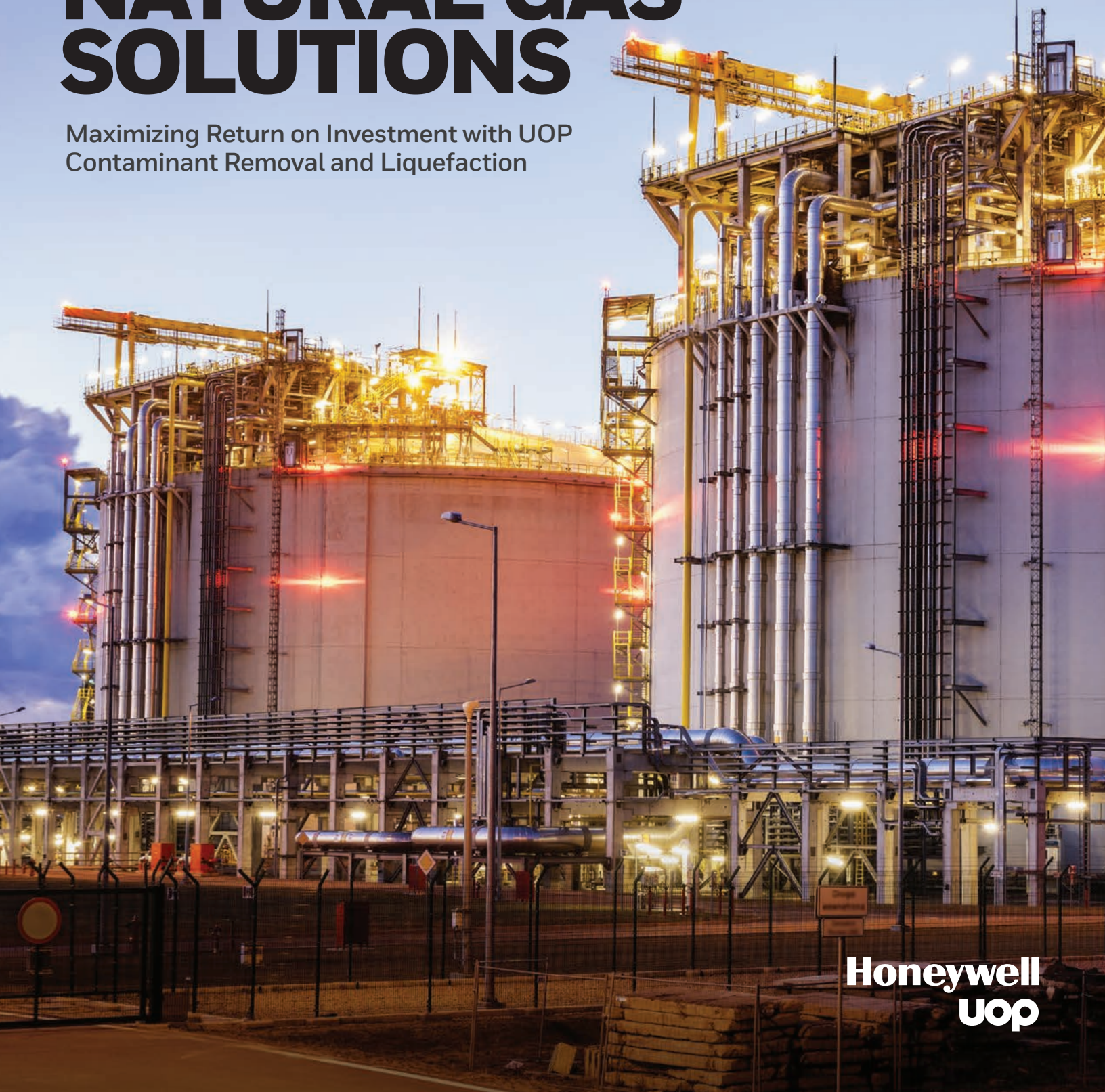


HONEYWELL UOP LIQUEFIED NATURAL GAS SOLUTIONS

Maximizing Return on Investment with UOP
Contaminant Removal and Liquefaction



Honeywell
Uop

FLEXIBLE AND RELIABLE LNG SOLUTIONS

Liquefaction of natural gas is an effective way to monetize the world's fastest-growing fossil fuel. To maximize return on investment and protect assets, it is critical to remove impurities from natural gas streams and cool the gas using the most reliable, efficient and cost-effective technology. Your success depends on pretreatment consistently meeting gas specifications and the plant maintaining steady operations. UOP offers the industry's most complete portfolio of liquefied natural gas (LNG) solutions designed to ensure on-specification treated gas and reliable production of cryogenic liquids. This translates directly to greater throughput, reduced utility consumption and maximum uptime.

ONE-STOP SHOP FOR LICENSING AND MODULAR UNITS

Based on a century of experience in the oil and gas industry, UOP offers a complete portfolio of flexible and cost-effective process solutions for LNG production to help operators reduce risk, reliably meet end-product specifications and earn greater returns. UOP's contaminant removal technologies are the industry's standard, pretreating 40 percent of the world's LNG.

UOP LNG pretreatment processes and equipment have been successfully deployed both offshore and onshore, including in baseload, mid-scale, small-scale and floating LNG (FLNG) operations. UOP Ortloff process plants for natural gas liquid (NGL), liquefied petroleum gas (LPG) recovery and LNG are recognized world-wide as industry-leading cryogenic processes for gas liquids recovery.

KEY ADVANTAGES

- Unparalleled experience from pretreating 40 percent of the world's LNG
- Reduced risk with proven reliability
- Flexible and cost-effective technologies
- Solutions for onshore and offshore
- Certainty to meet end-product specifications, while protecting downstream equipment
- Lowered capital and operating costs
- Options for licensed technologies and modular units





UOP LNG PRETREATMENT SOLUTIONS

UOP's broad range of LNG pretreatment solutions remove impurities, including mercury, acid gas, water and heavy hydrocarbons from natural gas streams. By removing these harmful contaminants upstream of liquefaction processes, plants can run with fewer upsets for longer intervals between shutdowns, adding to

bottom-line performance. Depending on operator needs, UOP processes can be delivered as licensed technologies or modular units.

Mercury Removal

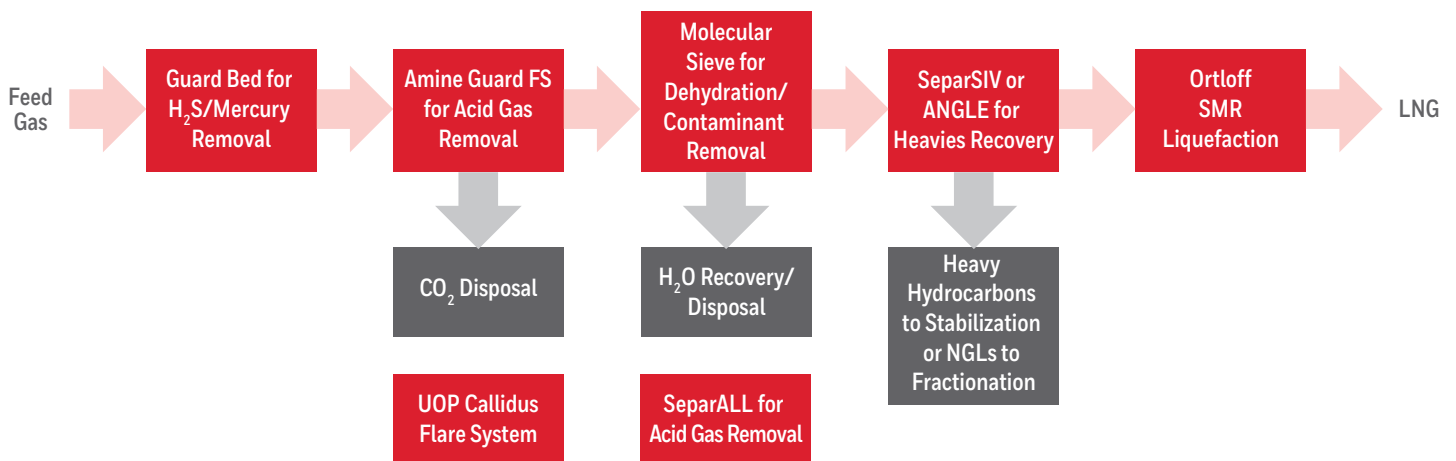
Both non-regenerative and regenerative mercury removal systems deliver a full-coverage process to protect the structural integrity of downstream equipment, reduce lifecycle plant costs

and extend unit life up to 30 percent compared to competitors.

- **UOP Non-Regenerable Guard Bed (GB) Adsorbents**

Copper-based UOP GB adsorbents offer higher capacity compared to sulfur impregnated carbon. This results in lower equipment cost and/or longer lifespan for fewer change-outs, minimizing the cost of mercury removal over time.

UOP can provide all your natural gas pretreatment, NGL recovery and liquefaction needs



Solutions Offered as Licensed Technology and Packaged Equipment



- **UOP Regenerable HgSIV™**

These silver-loaded molecular sieves are specifically formulated to remove mercury and regenerate with a clean gas stream. They can be loaded into an existing molecular sieve dehydration unit to simultaneously remove mercury, water and other impurities.

Acid Gas Removal

UOP offers both bulk and selective acid gas removal solutions to efficiently and effectively remove hydrogen sulfide and carbon dioxide upstream of liquefaction.

- **UOP Amine Guard™ FS**

The Amine Guard FS process combines high-performance formulated solvents with UOP's reliable Amine Guard process technology for bulk, selective or trace acid gas removal. This customized solution for LNG applications protects downstream equipment by reducing carbon dioxide, hydrogen sulfide and other sulfur components to very low levels.

- **UOP Separex™ Membrane Systems**

For remote locations, offshore installations or bulk acid gas removal requirements, Separex membrane systems efficiently remove acid gases and water with minimal operator

intervention and maintenance. These modular units provide lower capital and operating costs, reduced weight and footprint and faster delivery and startup compared to conventional processes.

- **UOP SeparALL™**

SeparALL process, the next generation of Selexol technology, uses a physical solvent to remove acid gas from gas streams. For LNG plants that employ molecular sieves to remove mercaptans in addition to dehydration, SeparALL can be utilized to separate sulfur from the spent regeneration gas.

MOLSIV™ for Dehydration and Contamination Removal

Effective dehydration is essential to avoid unplanned shutdowns, costly equipment repairs and hazardous working conditions. UOP is the leading worldwide supplier of dehydration adsorbents upstream of liquefaction, including the UOP MOLSIV adsorbents, an industry standard for more than 60 years.

Approximately 70 percent of the world's natural gas used in LNG production is dehydrated using UOP molecular sieves. UOP molecular sieve process technology is used in over 2,400 units worldwide over a broad range of operating conditions.

Molecular sieve process technology can be used for acid gas removal, dehydration, hydrocarbon removal and desulfurization of either natural gas or hydrocarbon liquids such as propane and butane. Either selective or complete removal of CO₂, H₂S, COS, mercaptans, mercury and organic sulfides can be achieved in these applications.

UOP MOLSIV UI-94

MOLSIV UI-94 adsorbent has demonstrated superior service life and more economical dehydration of water-saturated natural gas and in systems where liquid carryover of water, hydrocarbons and treating chemicals is of concern. Its special formulation resists coking from heavy hydrocarbons and treating chemicals, retains high water capacity and resists particle breakup caused by liquid carryover and reflux.

UOP MOLSIV UI-900

This clay-bound, high performance molecular sieve offers approximately 10 percent more adsorption capacity compared to 4A type sieve typically used in the LNG industry. It reduces operating costs through longer adsorption time, fewer cycles, longer life and reduced energy consumption.

Heavy Hydrocarbon Removal

By removing heavy hydrocarbons from natural gas streams, UOP's feed-gas-flexible processes prevent freezing and plugging in the main heat exchanger to protect equipment and avoid unnecessary downtime. Additionally, the heavier liquids recovered can be sold as valuable byproducts to generate increased revenue.

- **UOP SeparSIV™**

When feed gas is lean, UOP's SeparSIV can save operators up to 50 percent lifecycle cost versus traditional heavies removal processes. Incorporating Temperature Swing Adsorption (TSA) technology, SeparSIV features a unique combination of adsorbents and a comprehensive control system to selectively remove C₅+ heavy hydrocarbons with minimal pressure drop. A total solution for your operation, it also removes water, coping with varying feed compositions and removing organic mercaptan sulfur as well.

- **UOP Ortlhoff™ Advanced Natural Gas Liquids Extraction (ANGLE)**

For feed gas rich in heavy hydrocarbons, the Ortlhoff ANGLE family of processes combines NGL and LPG recovery with LNG production into a single, efficient process. An integrated ANGLE system creates up to 25 percent more value than independent processes through reduced capital costs, better efficiency and optimal hydrocarbon recovery.

All In SeparSIV eliminates the need for an amine unit and liquid solvents.

SOLVENT-FREE PRETREATMENT

Traditional LNG pretreatment removes acid gas with an amine unit, which requires additional equipment footprint, solvent inventory management and maintenance. With a solvent-free LNG pretreatment scheme, operators can reduce inventory and equipment needs and simplify operations.

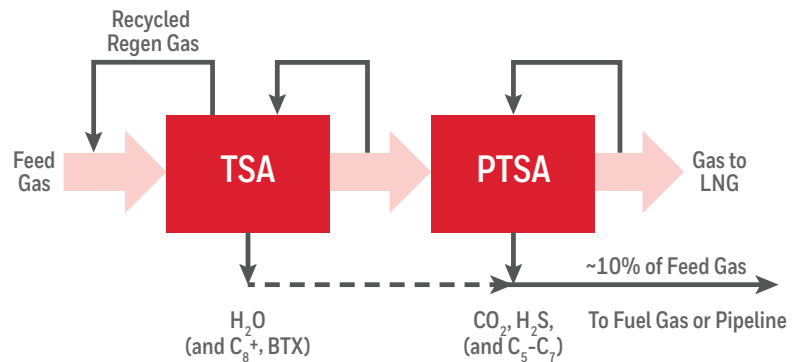
UOP All In SeparSIV™

UOP has developed a simple, cost-effective approach for LNG pretreatment that eliminates the need for an amine unit

and liquid solvents. Through a unique combination of adsorbents and a comprehensive control system, UOP All In SeparSIV is a Thermal and Pressure Swing Adsorption (TPSA) system that removes carbon dioxide, water and C₅+ heavy hydrocarbons in a simple adsorption-based system with very little pressure drop.

LNG plant owners and operators can save up to 25 percent lifecycle cost versus conventional pretreatment by eliminating amine equipment and solvent inventory, reducing plot space and minimizing purged regeneration gas, which can be used for fuel gas.

All In SeparSIV Solvent-Free Pretreatment System



Modular All In SeparSIV





UOP LIQUEFACTION TECHNOLOGIES

Ortloff ANGLE

Ortloff ANGLE processes integrate the most effective and efficient NGL/LPG recovery process designs into any commercially available LNG liquefaction process. By combining NGL recovery and liquefaction in a single step, plants can significantly reduce equipment needs and power consumption for lower capital and operating costs. It offers high NGL/LPG recovery to generate additional project revenue.

Ortloff Single Mixed Refrigeration (SMR)

Through a simple design with integrated liquids recovery, Ortloff SMR processes require the least amount of plot space, reduce capital costs and offer an excellent balance between efficiency and simplicity of design relative to base load and nitrogen cycle designs. This flexible process technology can handle a wide range of inlet gas compositions without a change in process configuration.

Ortloff Open Cycle Methane Process (OCX)

The Ortloff OCX process is a simple yet efficient liquefaction process that utilizes components in the inlet natural gas stream as the refrigerant. There is no need to store multiple refrigerant components or maintain a mixed refrigerant loop. Heavy ends removal or full NGL/LPG recovery are integrated seamlessly into the liquefaction process.

Ortloff LNG Fractionation Process (LFP)

Ortloff LFP technology combines Ortloff hydrocarbon recovery technologies with commercially available vaporization processes for NGL/LPG recovery at an LNG import or storage terminal. This allows operators to take advantage of multiple sourcing of LNG while still meeting pipeline natural gas heating value specifications regardless of the LNG origin. The valuable heavier liquids recovered can be sold to increase profitability.

AUTOMATION WITH HONEYWELL PROCESS SOLUTIONS

Honeywell provides comprehensive solutions for instrumentation, measurement, automation, safety, security and maintenance for the LNG industry. These solutions operate the LNG asset, protect key assets including property, people and the environment and maximize production. Honeywell's suite of advanced applications enable digital transformations, deliver real-time optimization of the LNG process, enable more reliable delivery to ADP and facilitate additional spot trade of LNG. Honeywell's capital project methodology, LEAP™ shortens project duration and reduces risk. Integrating a Honeywell automation system into the pretreatment process allows processors to design the automation system sooner and better optimize it for the plant design, which minimizes time, cost and risk.



MODULAR DELIVERY

UOP LNG process technology can be factory-built using a unique modular design and construction approach that allows for quick construction, predictable costs and schedules and superior quality. Similarly, through a cooperative technology agreement for liquefaction, modularized small-scale LNG packages can also be provided. The skid-mounted units are shipped by truck or barge for fast and easy installation, so operators can quickly begin earning revenue.

Benefits of modular delivery include:

- Predictable, repeatable designs
- Reduced costs and schedules
- Faster start-up and return on investment
- Efficient fabrication with superior quality
- Simplified maintenance and training
- Reduced safety incidents

Truckable Modular LNG Equipment



Amine Treater



Dehydration



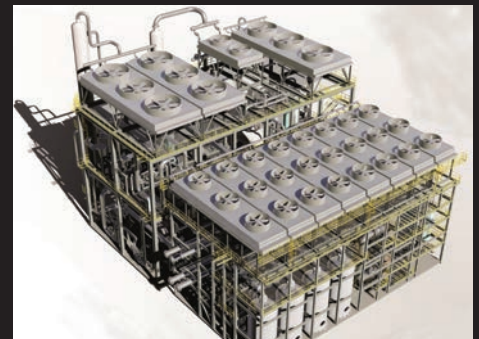
Amine Regenerator



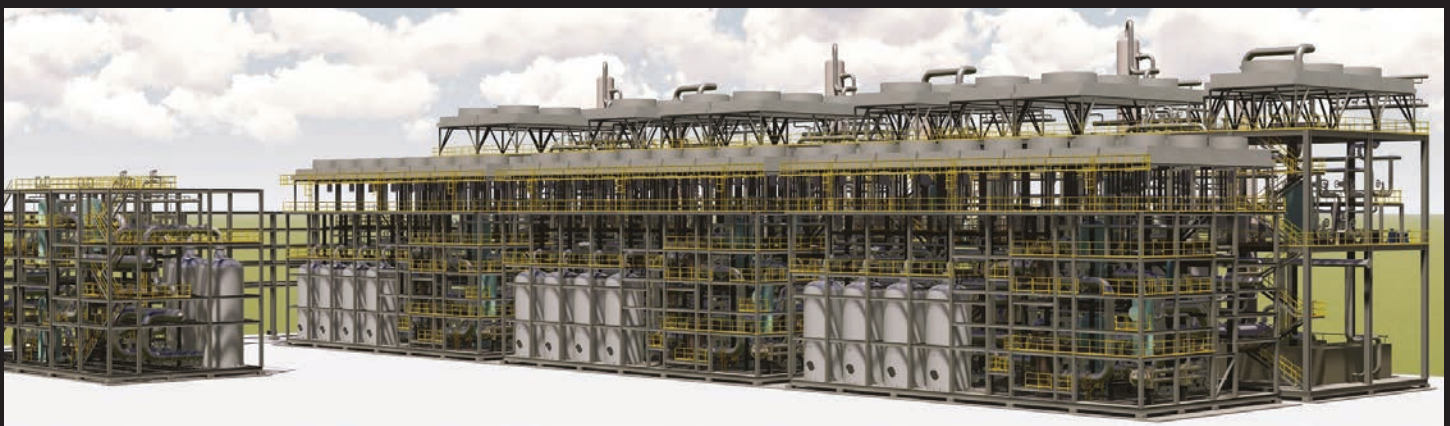
SeparSIV

Large Modular LNG Equipment

UOP offers large, factory-built modules for baseload LNG also using a unique modular design and construction approach that allows for superior quality with faster installation and start-up at a significantly lower Total Installed Cost (TIC).



Single Acid Gas and Dehydration Module



Three Trains of Modular Acid Gas and Dehydration plus a Single Mercury Removal Unit

DEDICATED AFTERMARKET SUPPORT

From start to finish, UOP global sales, engineering, service and support staff is there to understand customer goals and ensure needs are met with proven products and technology. UOP's dedicated customer support organization addresses aftermarket needs, including retrofits and revamps, debottlenecking and capacity increases, process performance improvement, hardware upgrades, licensor training for engineers and operators and field support supervision. Extensive service offerings, coupled with unmatched technical knowledge and experience, can help gas processors focus on profitability.

CONNECTED PLANT

UOP's connected solutions and services ensure that gas processing plants run at the peak of their capability. The Honeywell Connected Plant is a suite of applications that delivers higher levels of safety,

reliability, efficiency and profitability. These proven industry solutions are based on decades of Honeywell's domain knowledge and controls experience. A connected plant turns data into actionable insight to optimize operations, predict plant failures and eliminate unplanned downtime.

- **UOP ArmGuard™ and Smart SeparSIV™**
All UOP process units can be connected with UOP cloud-based software solutions. ArmGuard is a connected solution for dehydration units, and Smart SeparSIV is connected to a SeparSIV unit. Both can detect process upsets in the adsorption units before they become potential problems allowing for corrective actions to avoid unscheduled shutdowns. Operators can monitor the operation of the TSA units remotely and take steps to optimize throughput, reduce utility usage and increase the useful life of the adsorbent.



MORE THAN 100 YEARS OF GLOBAL EXPERIENCE, AND COUNTING

UOP provides process technology, materials, and equipment for gas processing, refining and petrochemical industries. With 19 engineering and R&D centers and 14 manufacturing facilities in 19 countries, UOP is close to its customers wherever they are. Since 1914, UOP has developed more than 70 licensed processes and 5,000 active patents and applications for the industries served.



OFFSHORE



LNG



ONSHORE

For More Information

To schedule a call or an onsite meeting to review your operation and needs, contact us at 847-391-2000 or visit uop.com.

UOP LLC, A Honeywell Company

25 East Algonquin Road
Des Plaines, IL 60017-5017, U.S.A.
Tel: +1-847-391-2000
www.uop.com



RESPONSIBLE CARE
OUR COMMITMENT TO SUSTAINABILITY

The information in this Honeywell Company document should not be construed as a representation for which UOP assumes legal responsibility, or an authorization or recommendation to practice a patented invention without a license.

UOP8459 | 09/19
Printed in U.S.A.
© 2019 UOP LLC. A Honeywell Company. All rights reserved.

**THE
FUTURE
IS
WHAT
WE
MAKE IT**

Honeywell
UOP