SOLVENT-FREE LNG PRETREATMENT: A SIMPLE ADSORPTION-BASED SYSTEM FOR ACID GAS, WATER, & C5+ HYDROCARBON REMOVAL

Trevor Smith  
Honeywell UOP

SUMMARY

Traditional pretreatment to protect the main heat exchanger from freezing and plugging involves a three-step process:
- An amine unit for acid gas removal (CO₂, H₂S)
- A MOL-SV unit for dehydration
- A cryogenic or SeparSIV™ unit for heavy hydrocarbon recovery or removal

This configuration requires the handling, monitoring and inventory of liquid solvents, the management of three waste streams, the allocation of plot space and the costs associated with installation of three process units.

A simpler, more cost-effective approach for LNG pretreatment is as:
- Thermal Swing Adsorption (TSA) and Pressure Thermal Swing Adsorption (PTSA) system.

This solution meets LNG specifications for CO₂ without the need for an amine unit and liquid solvents, removes H₂O, and selectively removes C5+ heavy hydrocarbons and BTX with little pressure drop, while retaining the C4+ fraction in the LNG product for Blu value.

The process is based on proven adsorption technology that selectively removes impurities through a unique combination of adsorbents and a control system.

The impurities are adsorbed in a feed-bed adsorber and desorbed by “swinging” the adsorbers from feed gas temperature (low) and pressure (high) to regeneration with high temperature and low pressure regeneration gas, similar in flow scheme to a dehydration unit.

OBJECTIVES

- Maximize LNG uptime by protecting the main heat exchanger from freeze-up
- Eliminate the amine unit and liquid solvents
- Meet LNG feed gas specifications with less capital and operating cost

TRADITIONAL PROCESS

PROPOSED PROCESS

- Adsorption: Feed gas is fed to the first unit - a temperature swing adsorption unit (TSA). The feed is fed to the designated vessel(s) in adsorption mode. Water, C8+ heavy hydrocarbons, and BTX are removed by UOP adsorbents as the gas flows downward through the vessel. The treated gas exits the adsorber vessel and is then filtered and delivered to the second unit - pressure thermal swing adsorption unit (PTSA).
- Regeneration: Treated gas flows upward through the vessel(s) that has completed thermal regeneration to cool the bed and prepare it for adsorption. Then the gas leaving the cooling bed is heated and used to regenerate the bed once it reaches the end of the adsorption cycle. The hot, spent regen gas flows through an air cooler, followed by a chiller (optional) to condense the impurities. The regen gas is then mixed with the regen gas from the PTSA or cooled to condense the liquids.

PRESSURE THERMAL SWING ADSORPTION UNIT

- Adsorption: Treated gas from TSA is fed to PTSA - a pressure thermal swing adsorption unit. The feed is fed to the designated vessel(s) in adsorption mode. In this unit, CO₂, H₂S, and C5-C7 heavy hydrocarbons are removed by UOP adsorbents as the gas flows downward through the vessel. The treated gas exits the adsorber vessel(s) and is then filtered and delivered to the liquefaction process.
- Regeneration: Hot gas is used to regenerate the bed(s) once it reaches the end of the adsorption cycle. Regeneration uses novel closed loop heating to reject CO₂, H₂S, and heavy hydrocarbons. This is then followed by depressurization and a purge step to sweep off the impurities. Feed gas is used to repressurize and cool the bed and prepare it for adsorption. The spent regen gas containing acid gas and C5-C7 is available for rejunction to the pipeline or for customer use as fuel.

BENEFITS

- Up to 25% lower Economic Lifecycle Cost vs Conventional Pretreatment
- Less installation
- Lower utilities consumption
- No Ame (no liquid solvents)
- Reduced plot space by ~30% (Good Fit for Floating LNG)
- Purged regen gas minimized to ~10% of feed
- Guaranteed to meet LNG specifications
- Delivers high-pressure product gas
- Selective C5+ removal to maintain Blu value

SOLUTION: ALL IN SEPARSIV™

For projects receiving lean and sweet gas as feed, the All In SeparSIV system provides up to 25% lower Economic Lifecycle Cost versus a traditional pretreatment flow scheme and is designed as an easier and more robust system to operate that offers:
- A simple, regenerative adsorption-based system
- Simultaneous impurity removal (acid gas, water, & C5+ hydrocarbon)
- Designed for feed gas with < ~2% CO₂ and < ~2 GPM heavy hydrocarbons
- Standard, pre-engineered, modular equipment units are available
- Higher capacities served by 'numbering up' modular units.

Contact

Trevor Smith  
Product Line Manager, Gas Processing & Hydrogen  
Honeywell UOP  
25 E. Algona Rd., Des Plaines, IL 60017  
Trevor.Smith@honeywell.com  
www.uop.com

RESEARCH & INNOVATION SHOWCASE  
研究与创新展示