

PRISM® GreenSep LNG Membrane Technology

Bio-LNG Made Simple

Background

In the production of (bio-)LNG, a market standard at the inlet of a liquefaction process is <50 ppm CO₂. This limit is set due to the risk of freeze-out/crystallization of CO₂ in the LNG liquefaction process. Common methods to reduce the CO₂ concentration at the inlet of the liquefaction process typically include amine scrubbing or thermal swing adsorption (TSA).

Generally, the biomethane at the outlet of a membrane unit contains ≤ 3 mol% CO₂. The CO₂ concentration needs to be further reduced to <50 ppm CO₂ before entering the liquefaction process. Therefore, biogas plants will typically utilize a TSA to meet the inlet specification of <50 ppm CO₂.

Air Products Membrane Solutions has successfully developed a specialized membrane called GreenSep LNG and an associated, proprietary membrane cycle that meets <50 ppm CO₂ at the outlet of the membrane unit, thus eliminating the requirement for an intermediate method to reduce the CO₂ concentration. This leads to reduced CAPEX, decrease in OPEX, and increased LNG production. The membrane and the associated cycle can be used for new installations, as well as to retrofit existing biogas upgrading plants that are converting to bio-LNG production.

Solution

Air Products Membrane Solutions' direct biomethane to bio-LNG solution consists of two innovative ideas that, combined, make GreenSep LNG possible.

This offering allows for simple and direct biomethane to bio-LNG production with a normal power consumption in combination with an increased bio-LNG recovery.

The innovation is put to work in the second stage of the cycle, where cascaded membrane series utilize a concept called "sweep." The permeate of the downstream membranes sweeps the upstream membrane in the cascading stage, improving the CH₄/CO₂ separation significantly.

Annual Savings

🔥 Energy

Energy reduction due to no heat demand for TSA/amine scrubber regeneration

⚙️ Simplicity

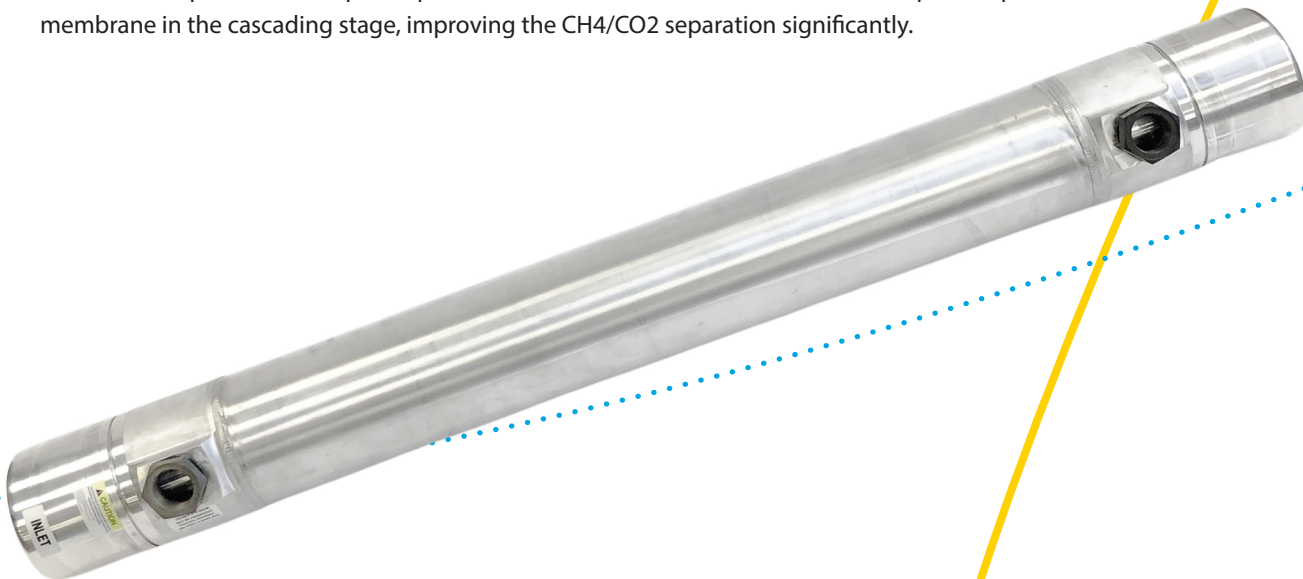
Straight forward system design with proven static "plug-and-play" membrane technology

📈 Production increase

100% of upgraded biomethane flow directly fed into the liquefaction process

🔧 Maintenance

Decreased maintenance costs and use of chemicals due to innovative design



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Comparison

A high-level performance comparison has been made with the GreenSep LNG cycle and a common market setup: a three-stage membrane system producing biomethane at >97 mol% purity, and downstream, a thermal swing adsorption (TSA) unit to meet the <50 ppm CO2 concentration requirement in the biomethane stream.

The reference case uses a standard biogas stream of 55% CH4 and 45% CO2. The flow used is 500 Nm3/hr raw biogas. Operating pressures and temperatures were kept at the same levels. Effects of other components (N2, O2 and H2O) were excluded from the comparison.

	Current market setup	GreenSep LNG cycle
CO2 concentration at membrane outlet	1-3%	< 50 ppm
Thermal swing adsorber	± 5 kWh	x
Power consumption heater TSA	✓	x
% regeneration of pure bio-CH4 to TSA	5-20%	x
% Final bio-LNG production increase	x	5-20%
Cost of TSA	\$160-220K	X
Membrane count	1x	1.5 - 2x
Power consumption	0.2 – 0.3 kWh/Nm3 raw	0.2 – 0.3 kWh/Nm3 raw
Consumables (adsorbent)	✓	x

Data above is based on estimates, project specific data will vary and impact performance.

Conclusion

The GreenSep LNG membrane product line and proprietary cycle improve the competitiveness of producing bio-LNG significantly by giving increased conversion from biomethane to bio-LNG. There are many more advantages to utilizing Air Products' PRISM® GreenSep technology, contact us to find out more!

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