

Innovative Nitrogen Rejection Solutions for LNG and Gas Infrastructure

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Nitrogen is widely considered as ballast in natural gas and other fuel gas streams, necessitating precise management to adhere to operational and safety standards. Pipeline gas specifications typically limit nitrogen content to a maximum of 3 mol% to ensure product quality and pipeline integrity. Similarly, fuel gas used for gas turbines requires strict nitrogen management to stabilize the Wobbe index and maintain reliable turbine performance. In LNG production, nitrogen concentrations exceeding 1 mol% present significant risks of LNG tank stratification due to varying densities, which could trigger the dangerous "roll-over" effect.

Nitrogen Rejection Units (NRU) offer an efficient and robust solution for nitrogen removal across diverse applications. Advanced NRUs are designed with CO₂-tolerant configurations, eliminating the need for Acid Gas Removal Units (AGRU) in pipeline systems, thereby reducing operational complexity and costs. Furthermore, nitrogen rejection is seamlessly integrated with end-flash gas (EFG) and boil-off gas (BOG) reliquefaction processes, essential for the electrification of LNG facilities. This approach not only enhances energy efficiency and minimizes hydrocarbon losses but also aligns with the global transition toward sustainable LNG production.

A critical benefit of modern NRU design is its role in mitigating greenhouse gas emissions. By minimizing methane content in nitrogen vent streams to below 80 ppmv prior to atmospheric release, these systems significantly reduce methane emissions, a potent contributor to climate change. This functionality ensures compliance with strict environmental regulations while supporting operators in achieving their sustainability goals. Additionally, the low methane content makes the nitrogen suitable for use in plant utility systems, without compromising on safety standards or operational reliability.

An additional capability of these NRU systems is the integrated helium extraction from nitrogen-rich end-flash gas streams, providing a supplementary revenue source for LNG operators.

Moreover, modern NRU designs incorporate operational flexibility, enabling operators to manage variations in nitrogen concentrations caused by diverse feedstocks, compositional feedstock changes over lifetime or alternating operations, such as ship loading, without compromising system performance.

Case studies illustrate the effectiveness of these nitrogen rejection solutions, including:

- N₂ removal from end-flash gas (EFG) at LNG plants, including LNG co-production
- Processing N₂ -rich boil-off gas (BOG) or EFG into LNG
- CO₂-tolerant NRU designs for pipeline gas processing without need of AGRUs
- Integration of Helium extraction into NRU systems to maximize resource recovery

Linde Engineering, being active in the field of cryogenic methane/nitrogen separation for 40 years provides detailed insights into process technology and corresponding equipment as well as operational experience.



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