# LNG: natural gas liquefaction

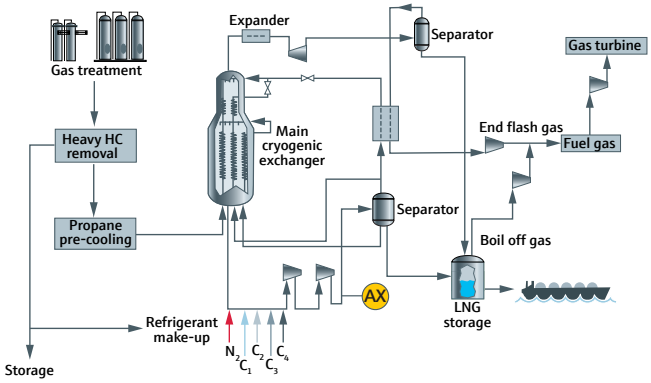


Figure 1: Example of a mixed refrigerant liquefaction process for natural gas

**Benefits at a glance**

- Measure MR in situ in the cryogenic liquid phase
- Measure gas-phase refrigerants at the sample tap
- Fast update times (seconds to minutes)
- No analysis delays due to sample transport or vaporization
- Measures a wide range of MR compositions and processes
- Does not shut down during flow interruptions; starts accurate analysis immediately upon flow resumption
- Lower OPEX

The majority of natural gas (NG) is transported in gaseous form via onshore or offshore gas pipelines. For stranded gas reserves where there is little or no local demand, or for long transport distances (>1000 km offshore, >3000 km onshore), it becomes more economical to liquefy the natural gas prior to transportation. In addition, due to the nearly 600-fold reduction in volume for LNG versus NG, LNG is often the preferred method for local storage.

## Measurement of refrigerants used in liquefaction

While there are multiple liquefaction processes in use at LNG facilities today, the majority of plants use some variation of a mixed refrigerant (MR) process. Since NG liquefaction can constitute over 50% of the CAPEX and 40% of the total OPEX of a baseload LNG plant, it is essential that this process unit be run as efficiently as possible. The ability to adjust the composition of the MR is a primary control parameter to allow a plant to maintain optimum efficiency during large turndowns, changes in feed composition, and accommodation of design uncertainties and off-design equipment performance. The Raman Rxn5 analyzer with a Rxn-41 cryogenic probe is a unique solution to the measurement of MR in the liquid phase. The ability of this system to measure in the pipe eliminates sample vaporization, transportation, and reduces lag time, providing composition updates in seconds, not minutes. When coupled with the Rxn-30 probe, the Raman Rxn5 analyzer can also measure MR in the gas phase.

## Issues with traditional measurements

Refrigerant composition for liquefaction of natural gas is typically measured with a process gas chromatograph (GC). Over time the MR composition can change due to losses. Changes as little as 0.02% Mol in the MR component composition can produce over a 5% reduction in energy consumption. Measurement uncertainties in the vaporizer-GC combination, combined with update times typically between 5 and 10 minutes, compromise its ability to provide an optimal level of control. In addition, heated sample transfer lines are required, adding lag time to the analysis.

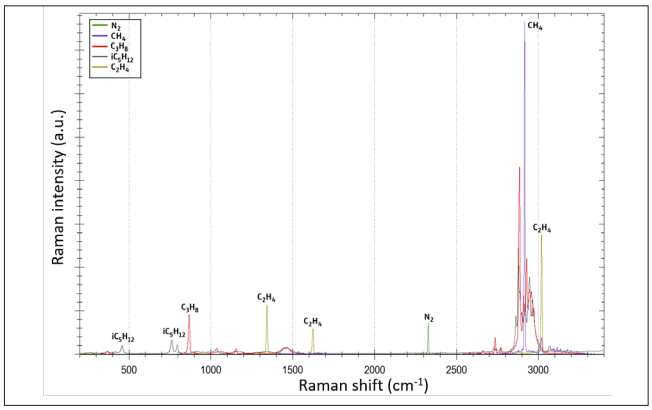


Figure 2: Raman spectrum for a typical mixed refrigerant sample

## Solution: Raman Rxn5 analyzer with a mixed refrigerant method

The Raman Rxn5 analyzer with the Rxn-41 cryogenic probe is capable of measuring the full composition of the mixed refrigerants, including $N_2$, at cryogenic temperatures, in the liquid phase and in the sample pipe, eliminating the need to vaporize the sample or transport it to the analyzer. With precision over 10 times better than a process GC/vaporizer solution, the Raman Rxn5 analyzer with an MR method is an ideal solution for optimum efficiency of the liquefaction plant under various operating conditions and with a wide range of NG feedstock.

The Raman Rxn5 analyzer with an MR method consists of the following:

- Raman Rxn5 analyzer base unit
- Rxn-41 probe for liquid-phase measurements
- Optional Rxn-30 probe for gas-phase measurements
- Fiber optic cable (length from 15 to 250 meters, customized to your plant requirements)
- Dedicated mixed refrigerant method

| Mixed refrigerant typical performance | | |
|---|---|---|
| **Component** | **Composition (Mol %)** | **Precision (k=2)** |
| Nitrogen ($N_2$) | 3.96 | < 0.11 |
| Methane ($CH_4$) | 39.51 | < 0.20 |
| Ethane ($C_2H_6$) | 47.54 | < 0.20 |
| Propane ($C_3H_8$) | 8.99 | < 0.04 |

Table 1: Typical composition and precision of a common mixed refrigerant

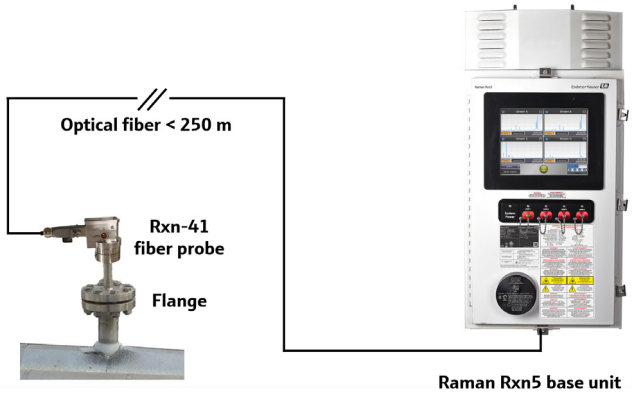


Figure 3: Recommended total process analysis solution



AI013466C/66/EN/01.21

Endress+Hauser
People for Process Automation