Case Study

CO_2 Vaporization Pilot Project – Ambient & Hot-Water Vaporizer Performance Testing

Introduction

Intero designed and executed a structured pilot project to evaluate CO_2 vaporization technologies under controlled field conditions.

The project systematically compared two vaporizer types – an ambient vaporizer (fan-forced) and a hot-water bath vaporizer – across multiple operating points, generating actionable engineering data for future industrial-scale CO_2 gas supply applications. The pilot project was conducted at the Intero facility in Hoogeveen, The Netherlands, and coordinated by the Engineering Department.

Asset Details

- Application: CO_2 vaporization (liquid → gas)
- Location: Hoogeveen, The Netherlands
- Equipment: Ambient AVU (fan-forced) + hot-water bath vaporizer
- Storage: LCO2 tank 18,000 L, 22 bar, with automatic pressure build-up
- Scale: Pilot / pre-industrial evaluation

System Components

- Storage – Cryogenic LCO2 tank 18,000 L, PRV set, level & pressure instrumentation
- Ambient AVU – Fan-forced finned vaporizer
- Vaporizing system, hot-water boiler 300 kW
- Controls – Control valves, T & P sensors, NRV, end manifold with safety valve
- Safety – PRV set, ESD, gas detection, vent to safe atmosphere
- Data – PLC data logger, digital T-recorders

Scope of Work

Intero was responsible for the full engineering, planning, and execution of the pilot program. The scope covered:

- Design and assembly of test set-up
- Testing of ambient vaporizer (fan-forced) across min / nominal / max flow rates
- Testing of vaporizing system in combination with a 300kW hot-water boiler across min / nominal / max flow rates
- Continuous logging of CO2 inlet pressure & temperature, outlet temperature, flow rate, and ambient conditions
- Performance evaluation, data recording, and comparative reporting
- Safety management: PRV set, ESD, gas detection, grounding, and vent routing

The Solution

Intero deployed a fully integrated pilot-scale test facility specifically engineered to evaluate the phase behaviour of CO_2. The system comprised a cryogenic liquid CO_2 storage tank (18,000 L capacity) equipped with an automatic pressure build-up system. The storage tank supplied both vaporizer technologies via a common distribution manifold fitted with dedicated process instrumentation.

Ambient Vaporizer System (Fan-Forced)

The ambient vaporizer consisted of an aluminium finned heat exchanger equipped with forced-air fans. The system was installed with a dedicated piping circuit, flow meter, dome valve, and dual temperature recorders. Testing was conducted with one to four operating fans to assess the influence of forced convection on vaporization capacity and CO_2 outlet temperature.

Hot-Water Vaporizer System

The hot-water vaporizer was integrated with a 300-kW hot-water boiler and condensate return system. Associated piping, an accumulator vessel, and crossover connections were designed and installed to ensure stable supply pressure across the full operating range evaluated during the test program.

A PLC-based data acquisition system with a laptop interface continuously recorded real-time process data throughout the testing campaign. All instrumentation was calibrated prior to testing in accordance with Intero's Quality Management System (QMS) procedures.

The Challenge

Intero CO_2 vaporization behaviour is governed by its phase diagram: liquid CO_2 can only exist above the triple point (−56,6 °C / 5,11 bar), and meaningful vaporization only occurs below the critical point (31,1 °C / 73,8 bar). Operating outside these boundaries risks incomplete vaporization, frost formation, pressure instability, or equipment damage.

The key technical challenges were:

- Maintaining stable outlet gas temperature across varying flow rates and ambient conditions
- Preventing ice formation on the ambient vaporizer fins
- Managing hot-water supply quality and condensate return for the vaporizer system
- Capturing sufficiently granular data to support scale-up decisions

The Result

Ambient Vaporizer (fan-forced)

- Stable vaporization at all tested flow rates (1,0 – 1,000 m^3/h) with 1 to 4 fans
- Outlet gas temperatures from +1 °C to +18 °C – confirming a strong correlation between forced convection and outlet quality
- In- and outlet pressure held stable at respectively 12,5 and 4,5 bar
- No uncontrolled frost formation or pressure excursions recorded

Vaporizer with hot-water generator

- Stable vaporization at all tested flow rates (1,0 – 1,500 m^3/h)
- Outlet gas temperatures from +1 °C to +20 °C – confirming a strong correlation between convection and outlet quality
- In- and outlet pressure held stable at respectively 12,5 and 4,5 bar
- No uncontrolled frost formation or pressure excursions recorded

Overall

- All data captured digitally for performance comparison and scale-up analysis
- Zero safety incidents throughout the full pilot programme

Advantages

- Fully engineered, turn-key pilot execution from design to report
- Dual-technology evaluation enabling direct performance comparison
- Proven ability to operate across a wide flow range. (1,0 – 1,500 m^3/h)
- Structured data collection supporting confident scale-up decisions
- Flexible system configuration enabling optimisation of vaporizer output
- Operator-friendly system design enabling simple, reliable day-to-day operation
- ISO 9001 / 14001 / 45001 / SCC-P certified execution

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