CO2 Vapor to Liquid Condensation

Exergy engineered a custom Shell & Tube Heat Exchanger to condense high-pressure CO2 vapor into dense liquid CO2, enabling efficient handling and utilization in downstream processes.

The Challenge

The customer needed to cool CO2 vapor entering the exchanger at **800–900 psi and 55°C** down to **7°C** to achieve a stable liquid phase. Operating at such high pressures and temperatures required a highly durable, compact solution. Standard exchangers posed risks of inefficiency, space limitations, and potential safety concerns.

The Objective

To condense high-pressure CO2 vapor into **dense liquid CO2**, enabling efficient handling and utilization in downstream processes. The solution needed to be compact, robust, and capable of sustaining continuous high-pressure operation without maintenance concerns.

The Solution

Exergy engineered a custom **Shell & Tube Heat Exchanger (Model #00486-09, 54 Series)** constructed entirely from 316L stainless steel, purpose-built for this high-pressure condensation challenge.

Shell Diameter

2.25"

Compact form factor for minimal footprint

Tube Length

20"

Optimized for efficient heat transfer path

Heat Transfer Area

10.08 ft²

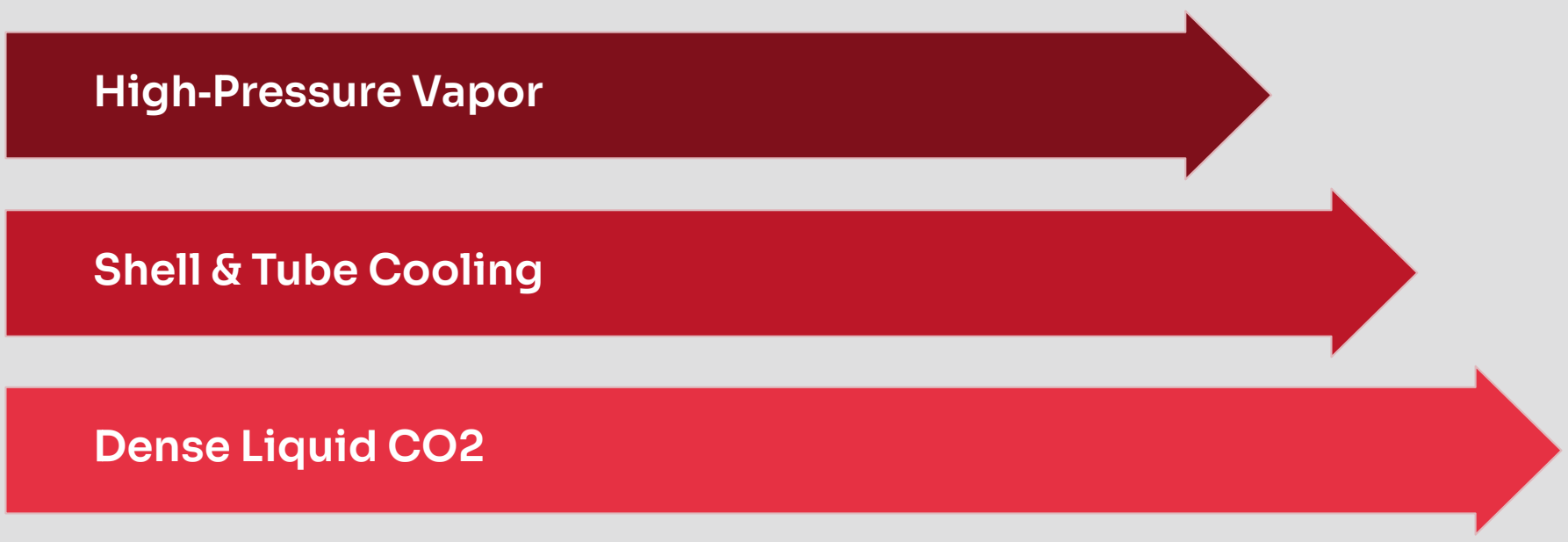
Maximized surface for rapid condensation

Material

316L Stainless Steel

Full construction for durability and corrosion resistance

The design utilized **CO2 on the tube side** and **ethylene glycol on the shell side** to achieve efficient cooling and condensation across the full operating pressure range.



Results & Benefits

Successful Phase Transition

The solution successfully cooled CO2 vapor to **7°C**, delivering cold, dense liquid CO2 for reliable and consistent process use.

Compact Footprint

The compact design minimized installation footprint, making it suitable for space-constrained industrial environments without sacrificing performance.

Zero Maintenance

Robust 316L stainless steel construction ensured long-term durability with **no maintenance required**, reducing total cost of ownership significantly.

High-Pressure Expertise

This project highlights Exergy's deep expertise in handling **high-pressure gas-to-liquid phase transitions**, delivering safe, reliable, and engineered-to-spec solutions.

This project demonstrates Exergy's capability to engineer custom thermal solutions for demanding phase-change applications combining precision design, material expertise, and compact engineering to solve complex industrial challenges.