FLOTECH

Sustainable savings in cryogenic storage.

Prepared Apr. 2026 by
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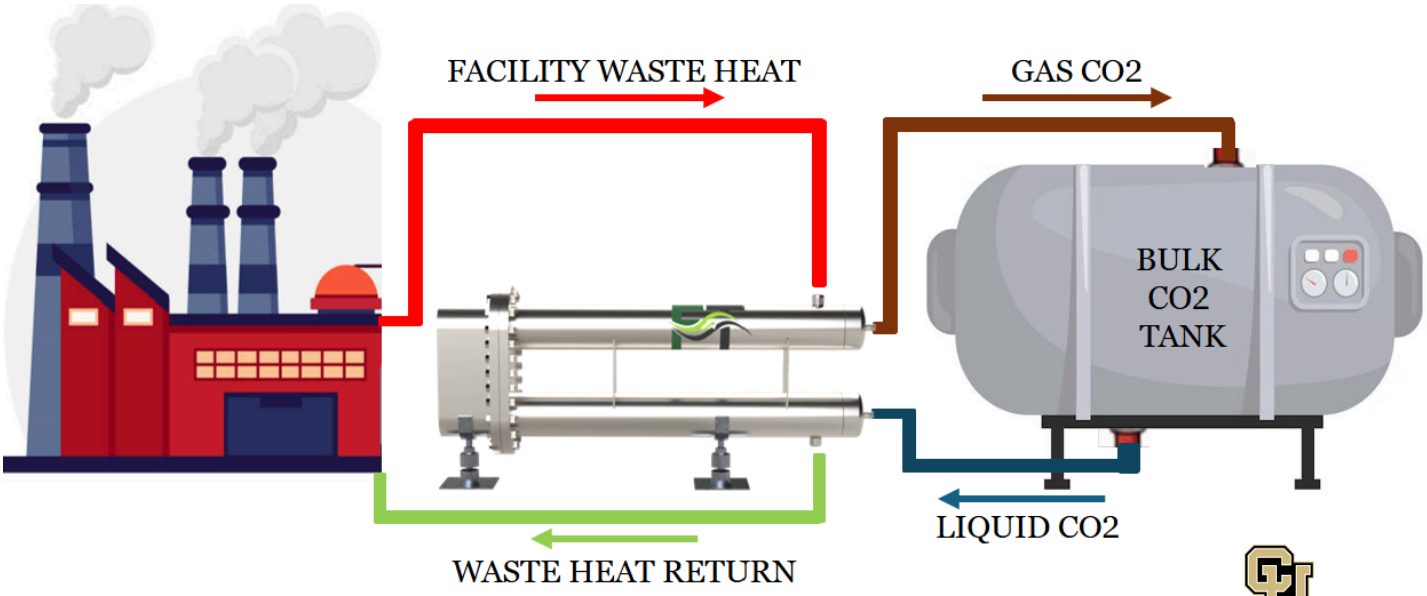
Background & Motivation

The EPA (Environmental Protection Agency) estimates that 33% of useful energy in the industrial sector is lost as waste heat.

Many industrial facilities require the use of cryogenic gases for their daily production processes. These are purchased and stored as liquids to minimize transport and storage costs. The liquid must be vaporized to the saturated gas phase before use in any facility, and current methods are energy intensive and costly. Facilities that use large-scale outdoor CO_2 storage tanks (storage capacity above 500L/~130gal) require pressure builders to maintain sufficient pressure for liquid phase while preventing freezing. Electric immersion heaters are standard for use as pressure-build systems, and cost tens of thousands of dollars per year to run. Meanwhile, other facility systems waste incredible amounts of heat through process fluid stream outlets and refrigeration cycles.

Flotech has designed a pressure-building heat exchanger that takes the waste heat from facility process fluid outlets and uses it to passively vaporize cryogenics, essentially eliminating expenditures normally associated with this process.

One relevant industry for us is brewing, in which mid/large-scale facilities use large amounts of gaseous CO_2 for beer carbonation and pipe-system cleaning. There are various other temperature and pressure-dependent processes present at brewing facilities, many of which produce waste heat output in either process water or glycol. These heat-storing liquids are ideal process fluids for shell-and-tube heat exchangers (HX). We have determined that incorporating a waste-heat process fluid heat exchanger into an existing pressure builder system would save energy costs substantial enough to validate a business case in the industrial sector, with mid-scale breweries as a beachhead market.



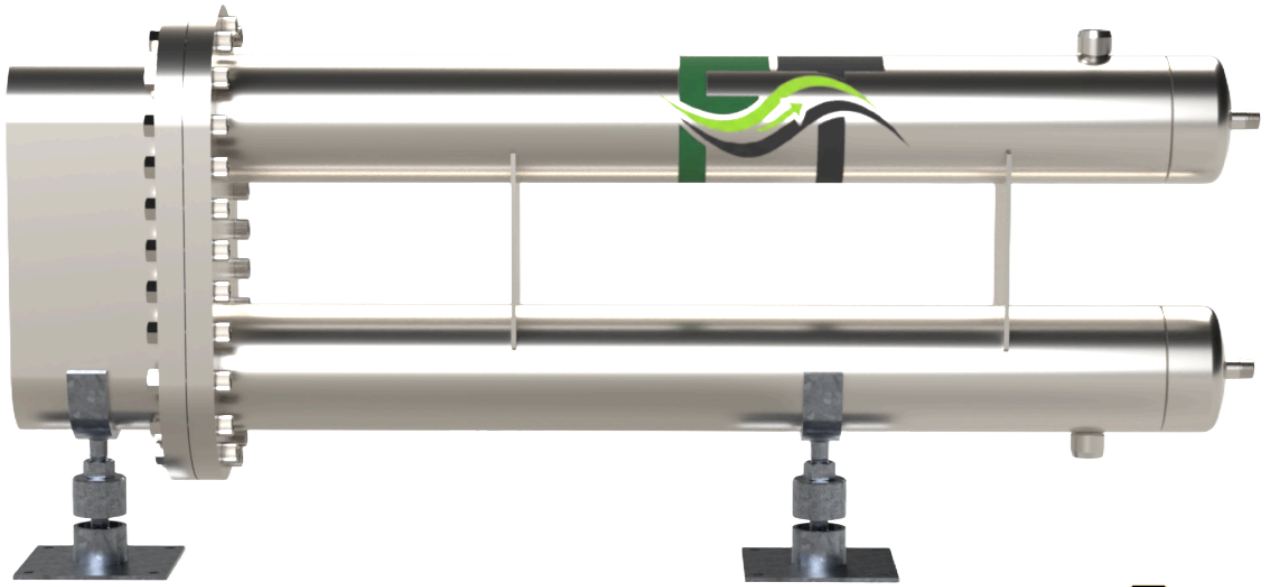
Design

Overview

We designed an industrial-grade U-tube shell-and-tube HX configured to vaporize liquid CO_2 using hot glycol, water, or other process heat streams. Sizing, HX classification, and materials were informed by Aspen Plus simulations and refined with Computational Fluid Dynamics (CFD) validation to ensure the device was designed to handle high pressures, flow rates, and temperature differences beyond off-the-shelf capabilities. The final full-scale design, intended for CO_2 compatibility, boasts a full stainless steel assembly. The liquid CO_2 flows through inner tubes arranged in a parallel triangular pattern, while hot process fluid flows across the outer pipe shell side, transferring heat to drive CO_2 phase change. The U-tube configuration accommodates material thermal expansion and minimizes stress from rapid temperature change, ensuring long-term durability under continuous operation. The shell allows for full fluid counterflow, maximizing heat transfer and minimizing necessary heat exchanger length.

Standards and Controls

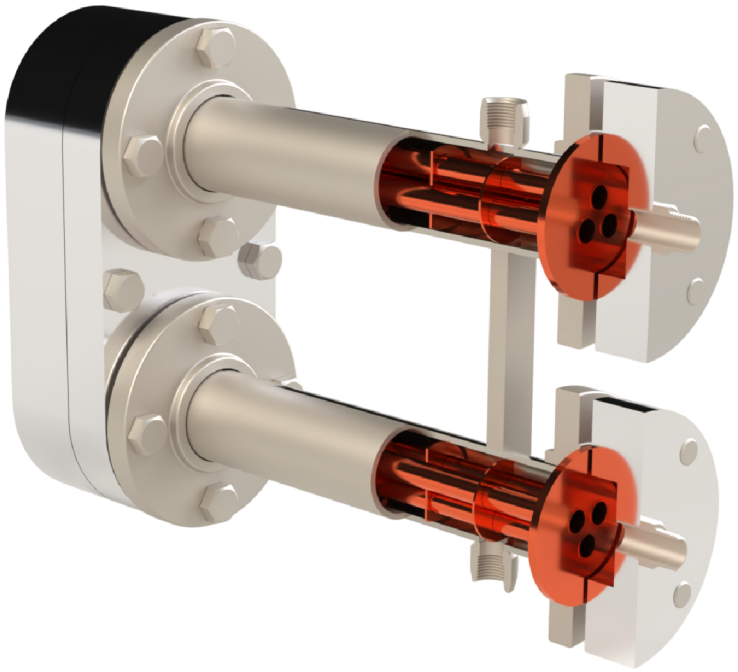
The system is compliant with standards set by ASTM, ASME, CGA, NFPA, ASHRAE, and the FDA. Design was also completed according to guidelines set by the Tubular Exchange Manufacturer's Association (TEMA). using 316L stainless steel for corrosion resistance, structural integrity, and food safety. Key components include a pressure-rated shell, tubes, tube sheets, baffles to enhance turbulence and heat transfer, and integrated control systems with flow valves, thermocouples, and pressure relief mechanisms. The HX can be fully integrated into a facility's existing SCADA system for all controls.



Simulation & Test Article

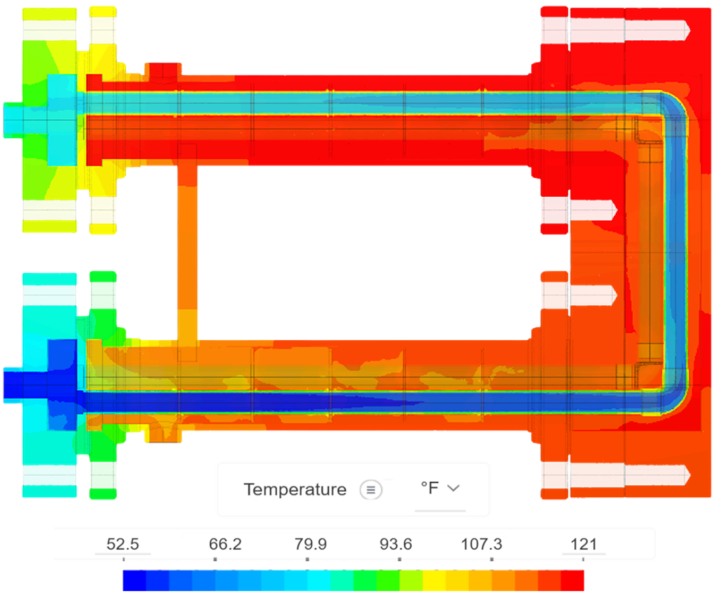
Prototype

We designed and built a scaled-down prototype of the Flotech pressure-building HX for initial testing, using water as both the 'shell' (hot) and 'tube' (cold) fluid streams. This test article has aluminum end caps and flanges, carbon steel pipes, and a copper internal assembly. It measures approximately 14" x 14", and weighs just over 40 lbs. National Pipe Thread (NPT) inlet and outlet connections allow for easy setup and takedown of the article's testing configuration.



Simulation

Simscale CFD simulation yielded heat transfer values to which we compared the results of the test described on the next page. This comparison allowed the team to understand performance differences between what was modeled in the simulation and the physical device's actual performance, informing changes to the full-scale design.



Testing

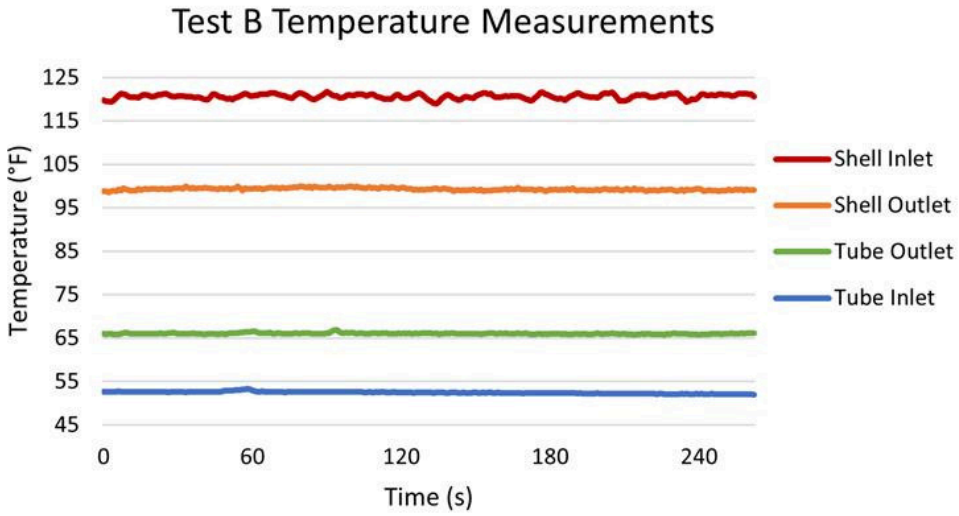
To verify the functionality of the prototype and inform the validity of the full-scale design, three tests were conducted.

Test A: Leakage

The device's core functionality is based on watertight construction, verified via this test. We pressurized the prototype to verify that both the shell and tube-sides of the heat exchanger were fully sealed, preventing any measurable water leakage when attached to both water sources at operating pressure. We used a pressure gauge to observe any pressure drop within each side of the system when isolated. This test was successful, yielding no noticeable leakage or pressure change on either side.

Test B: Heat Transfer

We tested heat transfer using a boil kettle and water faucet to validate that the Simscale model is representative of the real-world achievable heat transfer. This test was successful, resulting in a measured temperature change of 12°F, 86% of the change predicted by CFD results that yielded a maximum difference of 14°F. Because our team is unable to test the full-scale HX given project constraints, this test allowed us to validate the methodology used to design both HX's.



Test C: Variable Heat Transfer

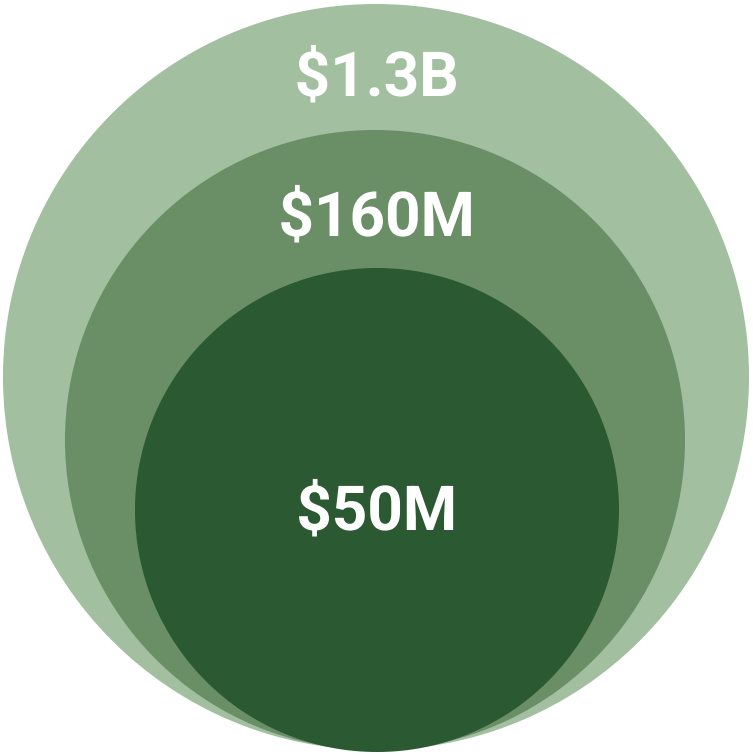
The third test involved varying the flow rate using an electronic flow valve control system to validate the assumption that the target and resulting heat exchange can be changed by controlling flow rates. A successful test is not denoted by a specific numerical result and was determined based on the available flow rates from the water sources. The core functionality of the full-scale design is the ability to vary heat exchange through flow rate control, which we validated by reducing flowrate from the maximum to see a proportional increase in heat transfer.

Market

Existing pressure build devices on the market are typically electric and expensive to operate. Even a single unit, like the one at local brewery Avery Brewing Company, can cost over $20,000 per year in energy expenditure. Extrapolating this issue across the industrial sector, this becomes a significant and largely overlooked cost.

The market for our passive vaporization solution is large and growing, driven by increasing energy costs and rising sustainability efforts at industrial facilities. Through customer discovery, we identified breweries as an ideal entry point: independently operated industrial facilities that are highly motivated to reduce both operating costs and environmental impact. Our conversations with local companies like Avery Brewing Company, Holidaily, Coors, and others validated strong customer demand, indicating this industry as an optimal market entry point.

Our serviceable obtainable market (SOM), consisting of mid-size breweries in the Western U.S., is valued at $50 million. Expanding nationally to our serviceable addressable market (SAM), the opportunity exceeds $160 million. Our total addressable market (TAM), including all U.S. industrial facilities with cryogenic gas needs, is valued at over $1.2 billion.



TAM

National Cryogenic Gas Applications

SAM

National Mid-Size Breweries

SOM

Western U.S. Mid-Size Breweries

Business Model

Entry Strategy

Many independent facilities are unable to access their cryogenic gas systems under contract with their bulk gas suppliers. The bulk gas market is tightly controlled, and major suppliers have little incentive to adopt new equipment when existing systems are profitable. To address this, Flotech seeks to partner with Energy Service Companies (ESCOs), leveraging their model of financing product implementation and their established relationships with both industrial facilities and suppliers. ESCOs will purchase our systems and cover upfront costs in exchange for a share of the energy savings. We will employ ESCOs to reduce risk for gas suppliers and enable facilities to lower operating costs without an upfront investment.

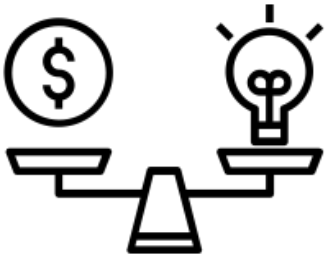
With a unit production cost of $20,000 we will sell to ESCOs for $35,000, with an additional $10,000 installation fee. We will also provide commissioning and maintenance for $7,000 per year, creating a recurring revenue stream while ensuring system performance.

Key Performance Indicators

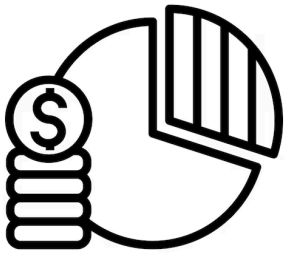
By working through ESCOs, we are also able to bypass the control of large gas suppliers to reach customers unable to finance energy saving technologies on their own. This combination of technical flexibility and market access positions Flotech uniquely among competitors. We are projected to generate $4.5 million in revenue by our fifth operational year and reach profitability early in year three after approximately 36 units sold. Gross profit margins will exceed 48 percent as production scales in year five. Additionally, our customer lifetime value is over four times our customer acquisition cost, indicating strong unit economics.



Year 5 Revenue
$4.5M



Break Even
Year 3 (36 units sold)



Year 5 Gross Profit Margin
48.3%

Conclusion

The Flotech advantage comes from our device's versatility, accessible to industrial facilities of all sizes and financial standings. Our system is modular and compatible with a wide range of gases after minimal redesign, allowing us to serve multiple industries nationwide. Current solutions offer electric pressure builders with broad gas compatibility *or* waste heat recovery systems with limited gas compatibility. As the sole provider of a multi-gas compatible waste heat pressure builder design, Flotech strives to serve all cryogenic gas-using facilities with *sustainable savings in cryogenic storage*.

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Our Team



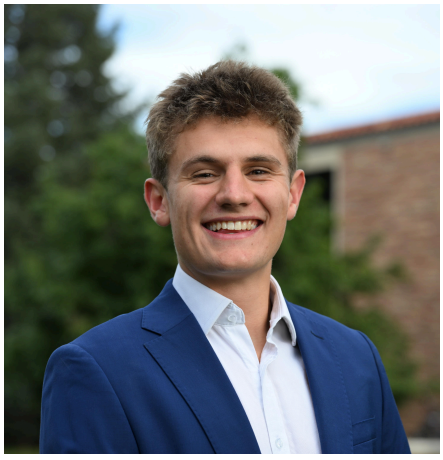
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