Helidyne

Planetary
Rotor
Expanders

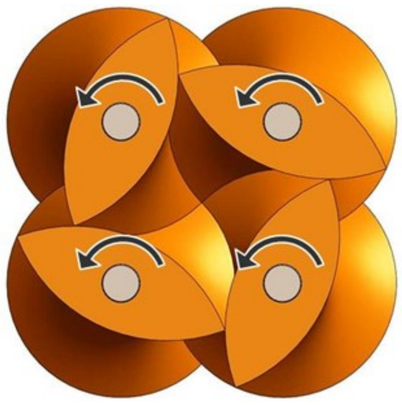
SMU

Simply put, an expander is the opposite of a compressor. As such, it generates useful energy rather than consuming it.

Helidyne has commercialized a new type of gas expander based on the Planetary Rotor concept. The expander can be used in a variety of applications to convert waste pressure into renewable electricity. The planetary design consists of four helical rotors that interleave in such a manner as to create an inner working cavity. With twice as many rotors as its closest competitor, it has twice the number of bearings to carry the load, making it the highest pressure rated expander in its class.

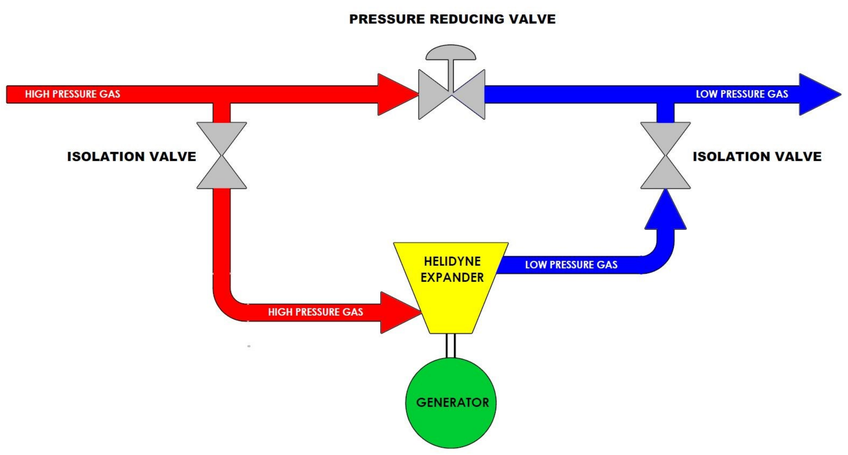
Competitive Advantage

	Planetary	Turbine	Twin Screw
Wet Inlet Gas	✓	✗	✓
High Pressure	✓	✓	✗
Self-Cleaning	✓	✗	✗
Variable Flow	✓	✗	✓



Typical installations include bypassing pressure reduction valves as shown in the diagram below. The expander is coupled to a generator to provide continuous base load power. With an inlet pressure rating of 1,440 psi and a maximum delta P of 1,000 psi, the expander can capture the full pressure drop available in a single stage for most applications.

Regulator Station

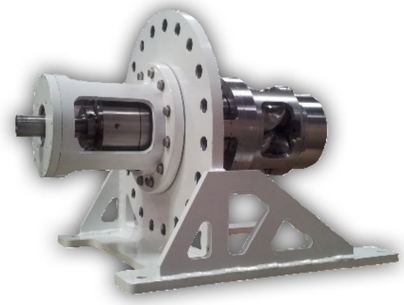


Power Generation

An order for (4) 60kW units for offshore oil platform use came in 2013 and a Series-A round of capital was raised the following year to support it.

In 2014 the company built a test stand using a large oil field gas compressor to simulate the operating conditions of the platforms (photo below). And by February 2015, the units were demonstrated for the customer and subsequently passed inspection.

In December of 2015, Helidyne tested its expander for waste heat applications using a refrigerant for the first time. The company's field test trailer was used to quickly make pipe connections; provide automated protective isolation valves; and extra DAQ capability.



The test was particularly exciting because it was the first time the expander was equipped with a cut-off valve to provide additional volume ratio. Matching the resource ratio to the expander is a key element to improving efficiency. The first test used a 2:1 valve, but much higher ratios will be tested in coming months.

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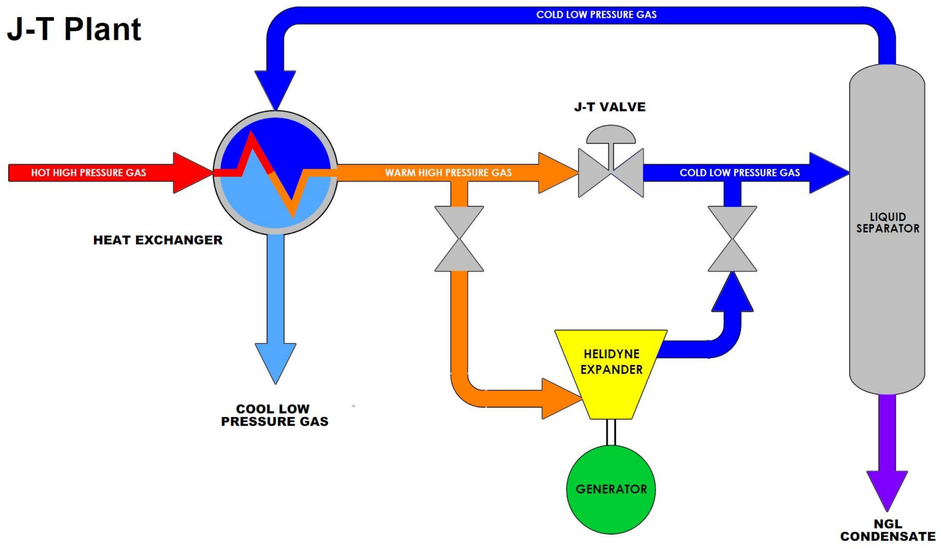
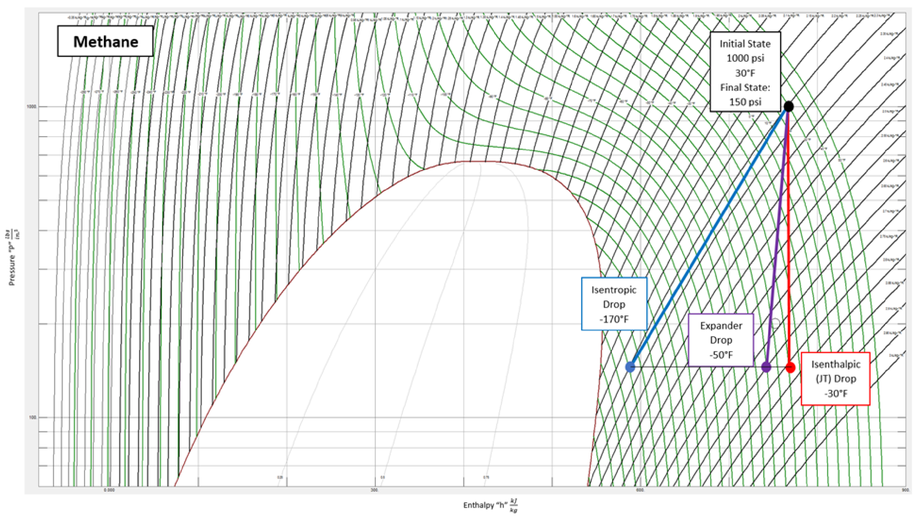
Helidyne's planetary rotor expander can be used to increase NGL (Natural Gas Liquids) recovery rates by up to 50% over traditional J-T skids, helping reduce wasteful flaring.

The following diagram shows how the J-T valve can be bypassed using the expander to improve process efficiency and generate electricity.



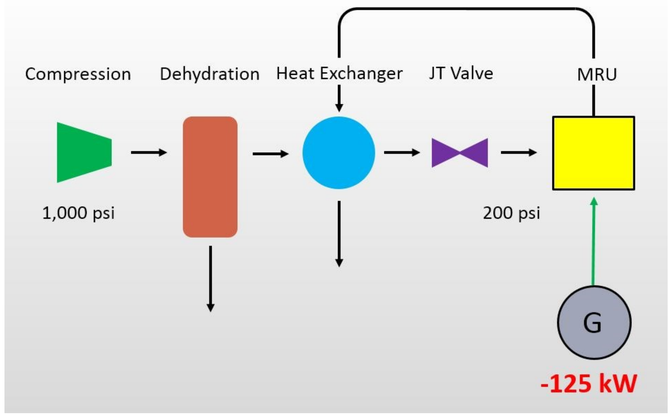
J-T valves rely solely on the cooling effect realized by certain gases that undergo free expansion. This throttling (isenthalpic) process is a complete waste of energy as shown by the vertical line in the Mollier chart below.



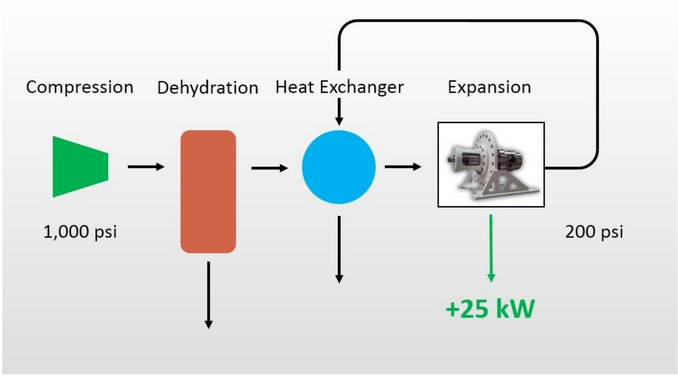
By comparison, the expander removes additional work energy from the gas stream to achieve greater cooling than the J-T valve, which increases the amount of NGL that condense or "drop out" of the raw gas stream. Electricity generated can be used for electric pipe heating to prevent downstream hydrate formation and power a PLC for remote monitoring to name a few.

Gas Processing

Oil fields like the Bakken in North Dakota produce very rich gas compositions that render the JT process inadequate. To remedy this problem, operators boost cooling capacity by adding an electric refrigeration unit (MRU). While this approach works with some degree of success, it has been plagued with reliability issues, can triple the cost, and consumes 125 kW of electricity for a typical site.



Helidyne's approach can achieve the same performance as the process above, but in a more simple and cost effective way. Rather than consuming 125 kW, the expander will be generating 25 to 30 kW of electricity, saving the expense of renting natural gas fueled generators.



Helidyne conducted it first gas processing test in North Dakota at a EOG Resources™ site in September of 2015. Using the company's outfitted mobile test trailer, the expander proved its ability to operate on rich field gas.

It also demonstrated that renewable power can be generated from an oil well using natural wellhead geopressure.

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